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ORAL FOCAL INFECTION: ITS STATUS TODAY, WITH PARTICULAR REFERENCE TO ARTHRITIS*

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The concept of chronic focal infection as a cause of systemic disease is now nearly a third of a century old. It was in April 1912 that Frank Billings[1] first reported his convictions on this subject. William Hunter,[2] of London, had several years earlier called attention to the dangers of infection in the oral cavity and had believed that such infection was a cause of anemia, gastro-intestinal disturbances and certain generalized pyogenic infections. His early work dealt chiefly with pyorrhea, ill-fitting dentures and crowns. It remained for Billings[1] to formulate the doctrine of chronic focal infection as we know it today. His first group of sixteen cases, ten of arthritis and six of nephritis, showed infection in the tonsils, removal of which had gratifying results as far as the general condition of the patient was concerned. Subsequent articles, 1913[3] and 1914,[4] further amplified the

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*The methods employed in treating arthritis represent, in brief, fifteen years' work by a group in the Arthritis Clinic, Henry Ford Hospital. A more detailed presentation by F. J. Sladen, C. M. McColl and D. C. Ensign is to be published in the near future.

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1. Billings, Frank: Chronic Focal Infections and Their Etiologic Relations to Arthritis and Nephritis. Arch. Int. Med., 9:484, April 1912.

2. Hunter, William: Oral Sepsis as Cause of Disease, Brit. M. J., 2:215-216, 1900; Oral Sepsis as Cause of Disease in Relation to General Medicine. Brit. M. J., 2:1358-1363, 1904.

3. Billings, Frank: Chronic Focal Infection as Causative Factor in Chronic Arthritis. J.A.M.A., 61:819, September 13, 1913.

4. Billings, Frank: Focal Infection. J.A.M.A., 63:899, September 12, 1914.

theory, and, in 1915, in the Lane Medical Lectures,[5] Billings summarized his views as follows:

1. A focus of infection is defined as "a circumscribed area of tissue infected with pathogenic micro-organisms."

2. The term "focal infection" implies that: (a) such a focus of infection is present; (b) the infection is bacterial, and (c) as such, it can be disseminated, leading to systemic infection or infection of other contiguous or noncontiguous parts.

3. The focus of infection may be located in any region of the body, frequently in the head as an alveolar abscess, a deep tonsillar or peritonsillar abscess or an area of chronic sinusitis, or in the gallbladder, appendix, fallopian tubes, seminal vesicles or prostate gland and as a subcutaneous or submucous abscess anywhere. He states that the overrepair of teeth may cause or prolong alveolar disease.

During the ensuing years, many articles on focal infection have appeared. The new concept seemed to meet with the greatest support in the Midwest. Laboratory experiments were devised. Rosenow's[6] theory of elective localization of bacteria was propounded. Enthusiastic and often uncontrolled clinical reports appeared, and soon a full-scale offensive was on against teeth, tonsils and other possible foci. No summary of the subject would be complete without a reference to Haden's[7] comprehensive studies on the relation of oral focal infection to systemic disease, with correlation of bacteriologic and roentgenographic findings. A thorough and sound presentation of the status of the theory after twenty-five years was given by Bierring[8] in 1938.

Always there have been those who were skeptical about the whole idea. Holman,[9] in 1928, presented a critical review, attacking particularly the theory of elective localization. He did admit that focal infection was of great importance in various human ailments, but stressed the facts as regards the host. One of his statements was: "What Rosenow and his followers particularly showed and what all the other investigators of the problem have definitely demonstrated is that streptococci do localize in various organs and tissues and can produce lesions at least sufficiently suggestive of those found in man so that their potential danger in infected foci cannot be neglected."

Especially in recent years, articles have appeared challenging the doctrine

5. Billings, Frank: Lane Medical Lectures, New York. D. Appleton & Co., 1915.

6. Rosenow, E. C.: Elective Localization of Streptococci. J.A.M.A., 65:1687, November 13, 1915.

7. Haden, R. L.: Dental Infection and Systemic Diseases. Philadelphia: Lea & Febiger, 1936.

8. Bierring, W. L.: Focal Infection: Quarter Century Survey. J.A.M.A., 111:1623-1627, October 29, 1938.

9. Holman, W. L.: Focal Infection and "Elective Localization": Critical Review. Arch. Path., 5:68-136, January 1928.

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of focal infection and particularly some of its applications. Such titles as "Focal Infection and Systemic Disease: A Critical Appraisal—The Case Against Indiscriminate Removal of Teeth and Tonsils," by Reimann and Havens,[10] in 1940, and "The Rise and Fall of Focal Infection," by Cecil,[11] in 1941, suggest the thoughts of the respective authors. To quote from the article of Reimann and Havens[10]:

"Cecil and Angevine say that focal infection is a splendid example of a plausible medical theory which is in danger of being converted by its too enthusiastic supporters into the status of an accepted fact. . . . Bloomfield regards the procedure (referring to the eradication of foci) to be now hardly more than a gesture or the remnant of a habit which enables one to do something in chronic cases in which there is so little to do."

We all recognize that, in the earlier days of unbounded enthusiasm, the pendulum did swing too far, and it is only natural that it should swing back in the opposite direction, with the truth, as always, lying somewhere between the two extremes. It, then, should be our purpose to try to evaluate in practical terms of today the theory of chronic focal infection as an etiologic factor in systemic disease.

Much of the apparent confusion and muddled thinking on the subject of focal infection results have their bases in several facts: First, that there is no clear-cut proof of the mode of action of a focus of chronic infection in causing disease at a distance. In some instances, metastasis of bacteria seems to occur; in others, the absorption of toxic products is thought to be important; while, in others, the existence of a state of allergy is postulated. A second fact is that many, perhaps most, of the conditions in which focal infection has been thought to play a part are diseases the exact etiology of which is still uncertain or unknown, and, as we shall indicate, focal infection is but one of many factors in the particular problem. Thirdly, some still fail to differentiate between cause and effect, between early changes and organized tissue changes; and the failure of established disease to be modified by eradication of a focus is unjustly held to be evidence against the original influence of the focus in initiating such changes. A fourth source of confusion consists in the making of general statements, rather than in confining observations to one disease or to one group of diseases. For this reason, most of what follows will pertain especially to the relation of focal infection to arthritis, and in particular to chronic nonspecific arthritis.

This emphasis on arthritis is further justified by the fact that chronic arthritis is one of the major medical problems of the day; not from the

10. Reimann, H. A., and Havens, W. P.: Focal Infection and Systemic Disease: Critical Appraisal—Case Against Indiscriminate Removal of Teeth and Tonsils. J.A.M.A., 114:1-6, January 6, 1940.

11. Cecil, R. L.: Rise and Fall of Focal Infection. Proc. Internat. Assembly of Inter-State Post-Graduate M. Assn. North America, 1941, pp. 301-304.

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standpoint of mortality, but from that of morbidity. Recent figures show that more than 320,000 persons, otherwise able, are made unemployable for an entire year in the United States alone by the rheumatic diseases. The National Health Survey has shown that these diseases represent the sixth greatest cause of disability, and rank third among those that disable persons for a year or more. The economic aspect of the problem, particularly in these days of manpower shortage, is thus seen to be tremendous.

First of all, we agree that there has been in the past a great deal of unnecessary sacrifice of good and useful teeth. Far too often, teeth have been removed "on general principles," before the indications for such procedure have been established. This practice is becoming less frequent. Today, in the Arthritis Clinic, we often receive patients for survey, referred by the oral surgeon to whom they had applied on their own initiative for complete dental extraction with the hope of clearing up arthritis.

Our approach to the problem of such a case of self-diagnosed arthritis is briefly as follows. The first step is to answer the question, "Is it arthritis?" As a rule, between 10 and 15 per cent of patients who presumed that they had arthritis are found to have some other disease accounting for their symptoms. If it is arthritis, as determined by preliminary observations, the next responsibility is to get exact information as to the type of the disease —whether specific or nonspecific, metabolic or infectious—and as to the stage and the present degree of activity. This calls for a detailed history and physical examination, with the aid of various laboratory tests and roentgenograms. If it is decided that the arthritis is specific, for example tuberculous, or is on a metabolic basis, as the arthritis of gout, interest in chronic focal infection becomes secondary indeed. If the case is one of acute arthritis, without a specific cause, such as the presence of the gonococcus, the search for foci is commenced as soon as the patient is reasonably comfortable. If the diagnosis is chronic nonspecific arthritis, a differentiation must be made between the two chief types: rheumatoid arthritis, also known as chronic atrophic arthritis or chronic infectious arthritis, and degenerative joint disease, also known as chronic hypertrophic arthritis or osteo-arthritis.

The differentiation between these two types will not be entered into in any detail, as that is not the purpose of this discussion; but to give a brief and concrete example, when hands are involved and the typical spindle-shaped swelling of the proximal interphalangeal joints of the fingers is present, with or without similar involvement of the metacarpophalangeal articulations, rheumatoid arthritis is present, but if the joint involvement is limited to the end joints of the fingers, giving a drum-stick appearance, degenerative joint disease is present. Of course, the diagnosis is seldom this simple, and, in many instances, the same patient will show varying degrees of both processes. The only reason for dwelling on this phase at even this length is to give point to the need of making such distinction

in the evaluation of any focal infection, as will be brought out later.

In both types of arthritis, six etiologic categories are considered, the relative importance of each varying somewhat in the two types of the disease. These causes may be enumerated as follows:

1. Hereditary influences, about which nothing can be done by the time the patient is seen, but which are of interest to the student of the disease.

2. Nutritional factors, which are of great importance in both types. Included here are not only the patient's habits of food selection, but also all influences in the absorption and utilization of the food taken. Here, in every case, consideration must be given to the mechanical condition of the patient's mouth—the adequacy of the masticatory surface—and it is here that we sometimes see the sad results of previous ill-advised and over-enthusiastic pursuit of focal infection, where too many teeth have been extracted without real indication and consequently without any benefit to the patient and, in many cases, with real harm from the nutritional standpoint. Many of the victims of the rheumatoid type of the disease show striking degrees of undernutrition as part of the picture; and if these people cannot chew the vitamin-containing and mineral-containing foods that they need, the problem of therapy is made more difficult.

3. Glandular and metabolic conditions, which seem to be of especial importance in degenerative joint disease.

4. Mechanical states, including weight, posture, body mechanics and injury.

5. Personality factors, which are of great importance, not only in the causation of symptoms, but also in their continuation.

6. Infectious conditions, which is where, in our panel, we come to the consideration of chronic focal infection. Fifteen or twenty years ago, this would have stood first on the list rather than last. It is our feeling that many failures in the treatment of arthritis in the past, and many of the current ones in some quarters, can be traced to the fact that sole reliance has been placed on the removal of focal infection, without reference to the condition of the patient as a whole and to the other causes mentioned above. When we come to the consideration of chronic focal infection in the particular case, the areas examined are teeth, tonsils, sinuses, gallbladder and prostate gland or pelvic organs. The need for searching all of these areas is obvious. Even when definite evidence of focal infection is found and eliminated in tonsils, for instance, an undiscovered infection that is allowed to persist in teeth may be of fundamental importance in keeping the arthritis active.

It is difficult to assay focal infection in nonspecific arthritis with accuracy. Degenerative joint disease will be considered first, because it outnumbers rheumatoid arthritis in cases 10 to 6, in our experience in this vicinity. The disproportion would be much greater if all patients with asymptomatic evidence of degenerative joint disease, either on clinical

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or by x-ray examination, were included, but we have indexed here only those persons in whom the degenerative manifestations were of such degree as to be a cause for complaint. Our thought today about this type of joint disease is that, in most instances, it represents not so much a disease *per se* as wear and tear and aging in the joints affected. The number of people showing these changes rises steadily with each decade, and in those persons who develop this type of joint disease before their chronologic age makes it likely, there is usually some explanation: excessive weight; trauma, either acute as in the baseball finger, or chronic as in the seamstress's finger, or glandular or metabolic changes. Hence, it is our belief that in such a patient chronic focal infection assumes little importance, or no greater relative importance than in the person without joint disease, or with other degenerative disease. From a practical standpoint, this means that if a detailed survey shows some condition to be present that should be cleared up in a "normal" person, such as advanced periodontoclasia, an alveolar abscess, a purulent sinusitis or a chronically infected gallbladder or prostate, the same indication for treatment exists as would be present if the patient had no arthritis, and the advice for such treatment would be based on improving the general condition and forestalling further complications, rather than on directly affecting the arthritis. As a matter of fact, the person with degenerative joint disease who has no evidence of rheumatoid changes can be reassured that his is not the severely crippling type of disease which leads to a wheel-chair or bed, and this reassurance alone is often an important part of therapy. It does not seem justifiable, at our present stage of knowledge, to be radical in our attitude toward questionable areas of focal infection in this type of problem.

In rheumatoid arthritis, on the other hand, and in "mixed" arthritis wherein the rheumatoid feature is an important one, chronic focal infection seems to play a more important part. This disease has many features suggestive of an infectious process. The patients are characteristically younger than those with degenerative joint disease, and have the appearance of chronic illness, with undernutrition, often secondary anemia, sometimes periods of low-grade fever, progressive and crippling joint involvement and an elevation of the blood sedimentation rate not present in degenerative joint disease. It is only fair to say that opinion is divided among those who have made a special study of this condition as to just how much focal infection actually has to do with the disease. Cecil,[12] who in 1927 was quite forceful in his statements about the role of infection in rheumatoid arthritis, has recently changed his views,[11, 13] concluding

12. Cecil, R. L., and Archer, B. H.: Chronic Infectious Arthritis; Analysis of 200 Cases. Am. J. M. Sc., 173:258-270, February 1927.

13. Cecil, R. L., and Angevine, D. M.: Clinical and Experimental Observations on Focal Infection, with Analysis of 200 Cases of Rheumatoid Arthritis. Ann. Int. Med., 12:577, November 1938.

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that this disease is rarely related to focal infection and stating that it usually comes on insidiously without any previous infection; that, in the majority of cases, there are no discoverable foci of infection, and that if foci are discovered, their removal has no permanent effect on the course of the disease. On the other hand, Hench[14] has recently stated his views as follows:

> As a clinical investigator I must conclude that the cause of atrophic (or rheumatoid) arthritis is still unknown and that the evidence for infection, although very impressive, is incomplete. Invoking the privileges of a clinical investigator I cannot and need not now decide for or against the microbic theory with any finality. As a practicing physician, however, I cannot wait until the evidence is complete. The exigencies of practice force one to express an opinion one way or another. . . . Therefore, as a practical clinician, I have committed myself to the microbic theory.

We favor Hench's view. Indeed, in almost all patients with this type of arthritis whom we see, it is possible to find hitherto missed areas of chronic infection, or to have a history of discovery of such lesions and their removal after onset of the disease. Multiple foci are often present. A commonly overlooked focus in our experience has been a root fragment with surrounding area of radiolucency in the roentgenogram, and with a positive culture of *Streptococcus viridans* or the nonhemolytic streptococcus often reported after extraction. That something besides such focal infection is necessary to the development of arthritis is obvious. It is a matter of soil as well as seed.

It must be added that rare indeed is the arthritis that can be cleared up solely by eradication of foci of infection, which explains many disappointments in the past. Instead, all departures from the normal that have been discovered in the diagnostic survey must be corrected as far as possible. The patient must be treated, not just the arthritis. The detailed therapy of arthritis is not within the scope of this paper, but brief reference to some features may be made. As is well known, there are almost as many forms of treatment for arthritis as there are physicians who are willing to attempt to treat the condition. In the past, it has been common for the practitioner to ride some particular hobby—extraction of teeth, removal of tonsils, the use of vaccines either autogenous or stock, some type of physiotherapy, various medications or injections calling for sulfur, chaulmoogra oil, bee venom, even "red ant juice," and many others. The use of high concentrations of vitamin D was brought to the general attention in a recent article in a popular magazine; and, while this does seem to be of benefit in certain cases, the results are actually much less striking than

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14. Hench, P. S.: Is Rheumatoid (Atrophic) Arthritis Disease of Microbic Origin? Survey of Arguments for and Against Infection Theory, in Survey of Chronic Rheumatic Diseases. London: Oxford University Press, 1938, pp. 35-62.

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would appear from perusal of the article referred to. Gold therapy is being critically evaluated and probably will eventually have a place in the treatment of selected cases, in spite of its many dangers. The very multiplicity of treatments advised makes it obvious that there is no one "cure." The only satisfactory way to handle arthritic patients, not only during the diagnostic period, but especially during treatment, is by a group or team so that all angles will be covered. An interested dentist is an indispensable member of such a team.

There are, of course, many conditions other than arthritis in which focal infection is thought to be of importance. Slocumb[15] and his associates at the Mayo Clinic have recently published an excellent summary in which they analyze their clinical impressions on this subject in connection with various types of heart disease, arthritis and glomerulonephritis. Their final conclusion was that their attitude in these several conditions varied from tepidity, as far as heart disease was concerned, through relative enthusiasm in the case of chronic infectious arthritis, to whole-hearted acceptance with regard to glomerulonephritis. Other systemic and local diseases in which focal infection is considered are certain types of anemia, chronic bronchitis and bronchiectasis, iritis, peptic ulcer, nonspecific colitis and some of the degenerative diseases, to mention but a few. Space does not warrant further detailed discussion of any of these subjects. The case cannot be considered finally proved or entirely disproved for most of them, and the merits must be judged carefully in the individual patient.

An often recurring question is what to do about the otherwise normal person in whom sites of chronic infection are discovered on routine physical or dental examination. If the evidence of such infection is definite, one's judgment would certainly dictate that the areas be cleared up at a convenient time, on the principle that such lesions cannot contribute anything to health, but must rather act as a subtracting factor. The threat of dire consequences should the patient not follow advice in this regard need not be made too emphatic or too specific, since some people elect to retain infection and seem to suffer no ill-effects, at least for a long time.

In the evaluation of possible hazards from oral focal infection, a complete clinical examination of the mouth by a dentist is essential, with the aid of full mouth x-ray films including all areas of previous extractions. Even in a patient who has worn full dentures for years without any discomfort and without any history of trouble following extractions, this is necessary if general symptoms exist that could be based on chronic focal infection. As mentioned before, it is surprising how many patients are seen who have been examined repeatedly for years and in whom the fact that the patient was edentulous had blocked consideration of dental foci but in whom root fragments with infection were discovered.

15. Slocumb, C. H., et al.: Focal Infection. J.A.M.A., 117:2161-2164, December 20, 1941.

The matter of periapical rarefaction is of great interest both to dentists and to internists. The recent article by Fish[16] gives an excellent explanation of resorption of bone about the tip of the root of an infected tooth. He believed that the granuloma that replaces the bone commonly shows round cells, but no polymorphonuclear leukocytes and no bacteria (unless an acute abscess has developed) because bone resorption is due to diffusion of toxic products from the site of actual infection, which is in the pulp itself, these toxins having stimulated osteoclasts to develop, while destroying osteocytes.

There can be no question in this day and age about the attitude toward a devitalized tooth showing periapical radiolucency in the roentgenogram, if the patient has arthritis, nephritis, heart disease or any other active systemic disease in which focal infection cannot be tolerated: such a tooth must be extracted. From the medical point of view, if a patient, particularly a younger person, has a devitalized tooth with periapical rarefaction, and this is an important tooth and one favorable for root canal work, and there is no systemic disease present, we have no objection to expert root canal treatment. In the presence of arthritis, we believe that such stirring up of possible infection would be a definite hazard. Even in a patient free from systemic disease, if the tooth does not respond to root canal treatment or is not suitable for such treatment, we believe that extraction is indicated, as mentioned earlier.

It is more difficult to crystallize a proper attitude toward the devitalized tooth that shows no periapical rarefaction. This subject has been debated for many years, with vigorous opinions freely expressed on both sides. Conflicting reports regarding cultures are to be found in the literature. Many statistics are vitiated by a lack of control of various factors, in culturing, such as contamination during extraction. Recent work by Stein[17] from the Oral Pathology Department of the Harvard Dental School has a bearing on this point. He exercised precaution in extraction, including thorough preliminary cauterization of surrounding gum tissues after preparation with iodine, and then cut off the apex with sterile cutting pliers and cultured it in Rosenow's brain broth and soft brain-agar. The use of this method, employing teeth with living pulps, when extraction was uncomplicated yielded positive cultures in 15 per cent of cases; which must be considered as indicating probable error in his other figures. Pulpless teeth that showed a radiolucent area in a roentgenogram gave a positive culture in 74 per cent. Those which were x-ray negative gave a growth of organisms in 71 per cent; a figure not significantly less than that for the x-ray positive teeth. Each of these figures included the 15 per cent probable contamination mentioned above. The figures for pulpless teeth were further broken down into various categories. Untreated pulpless teeth, teeth

16. Fish, E. W.: Bone Infection. J.A.D.A., 26:691-712, May 1939.

17. Stein, George: Newer Aspects of Problem of Focal Infection. Am. J. Orthodontics, 28:28-42, January 1942.

with pulps amputated and teeth with root canals filled, but not to the apex, all gave positive cultures in from 74 to 79 per cent. Forty-five per cent of teeth in which the root canal was filled to the apex or overfilled showed growth. Subtracting the 15 per cent probable error leaves 30 per cent, or a 1 to 3 chance that infection was present. About twelve years ago, Rhoads and Dick[18] reported the results of quantitative culture of a small group of roentgenographically negative pulpless teeth with root canal fillings, finding an average bacterial count of 759,574 per tooth. Vital, roentgenographically negative, healthy teeth treated in similar manner gave an average bacterial count of 1,876 each, almost exactly one four-hundredth of the figure for devitalized teeth; a convincing difference. In spite of this evidence against pulpless teeth, from the medical standpoint we are inclined to take a reasonably conservative attitude. If there is no suggestion of systemic disease that could be related to focal infection, we are usually content to let the questionable tooth remain, provided the patient fully understands the potential danger and can be trusted to have periodic examinations, both dental and medical. This is especially our attitude if the root canal is properly filled. If the patient has a disease, such as arthritis, in which we believe that focal infection is playing a part, and has other more obvious foci than a roentgenographically negative pulpless tooth, we attack the more likely areas first. Then if the general trouble progresses in spite of care in other departments, and we believe it necessary to be absolutely certain that there is no focus of infection remaining, we are constrained to recommend extraction of such a tooth. In other words, our attitude toward a given type of tooth depends upon our clinical judgment concerning the individual patient.

The importance of periodontoclasia deserves more than passing mention. This is frequently overlooked as a focus, partly because it is such a common condition and partly because many physicians believe that the lesions of pyorrhea have free drainage to the outside and therefore not much general absorption is apt to occur. However, when the lesion is advanced enough to cause pockets and visible bone destruction, especially with extension beneath the bifurcation of a molar or bicuspid, such a pocket can be as much of a focus as an infected tonsil crypt. Incidentally, the mechanism of bone absorption here is explained by Fish[16] as being similar to what occurs in the so-called alveolar abscess. The actual bacterial infection is in the soft tissues of the pocket, and the absorption of toxins from this area kills osteocytes in the neighboring bone and increases the number of osteoclasts. Christensen[19] has pointed out that an area of advanced periodontal disease around one molar tooth presents a surface of purulent ulceration

18. Rhoads, P. S., and Dick, G. F.: Roentgenographically Negative Pulpless Teeth as Foci of Infection: Results of Quantitative Cultures. J.A.D.A., 19:1884-1893, November 1932.

19. Christensen, G.: Periodontal Disease and Medical Aspects. M. J. Australia, 2:157-160, August 16, 1941.

about the size of the thumb nail, and that in a mouth with twenty-eight teeth, in an advanced state of disease, the total area of surface from which absorption can take place is approximately 20 square inches. He comments truly that it is impossible to imagine the treatment of a chronic suppurating ulcer of this size anywhere else in the body with such indifference as that displayed toward this type of oral infection. He lists the facts, in addition to the area of involvement, that render the periodontal pocket a favorable site for toxic absorption, as follows:

1. It is an abnormal site of bacterial implantation with definite evidence of reaction on the part of the soft tissues.

2. Through breaks in the epithelial lining of the pocket, bacteria and toxins can easily enter underlying tissues.

3. The absorption of such toxins, and even the entry of bacteria into the blood stream, are made easy by the presence of rich capillary beds near the surface.

4. Mechanical irritation from calculus leads to continued capillary response in the adjacent soft tissues.

5. The mobility of a tooth in its alveolus aids toxic absorption, the tooth acting as a piston in pumping bacteria from the crevice through breaks in the epithelial lining into the area of rich capillary supply. He refers to the work of Okell and Elliot and others in which bacteremia of proved oral origin resulted from the chewing of paraffin for seventy seconds by a person with periodontal infection.

Finally, the need for close cooperation between the dentist and the physician in the management of cases involving oral foci of infection may be stressed. The fundamental aim of both the dental and the medical profession has undergone a progressive evolution. Formerly, the chief object was relief of symptoms and attempts to correct existing disease. More and more each year, emphasis is being laid on prevention, the detection of trends and early changes with a view to forestalling established disease. The dentist has been termed the "physician and surgeon of the mouth." The progressive attitude of the modern dentist has certainly played a distinct part in raising the general health level of the population. It is comparatively rare nowadays to see patients with the extensive periapical disease that was seen so commonly twenty or twenty-five years ago even in those who could afford good dental care. We can speak with great respect from the standpoint of the physician as to the value and need of dental aid in the efforts not only to cure people, but also to keep them well, and we believe that members of the dental profession are becoming increasingly alert to the reflections of systemic conditions as seen in the oral cavity and are, in many instances, directing patients to medical care sooner than would otherwise be the case. It becomes daily more apparent that for the maintenance of our professional standards and aims, even closer harmony and unity of purpose must be the watchword.

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The possibilities for cooperation in the individual case extend throughout the periods of diagnosis, active treatment and follow-up or after-care. The matter of diagnosis has been spoken of before. It may be emphasized by stating that, for best results, it is important for the physician to make clear to the dentist how strict the search for foci is to be—whether definite foci only are to be detected or possible or questionable areas are also to be considered. As mentioned before, this depends in large measure on the clinical evaluation by the physician as to the type and activity of the general process going on in the individual patient.

In treatment, there are two chief aspects of the teamwork of the dentist-physician combination. The first has to do with selection of the best time to attack the foci, and the amount of work to be done at any one time. Here, too, no hard and fast rules can be laid down. In general, in arthritis, we prefer to have the activity of the disease under control and to have well under way general measures to improve the systemic condition before undertaking surgical procedures. In individual cases, it may seem important to go ahead without further delay. Indeed, occasionally, the clearing up of a definite focus proves to be the one mechanism for terminating the activity of an arthritis. Again, the decision as to the amount of trauma to which the patient can safely be exposed at one sitting should be made both by the physician, who is the best judge of what the patient can tolerate, and by the dentist, who alone can estimate the technical factors involved in the proposed work that is to be done.

The second great field for cooperation in treatment has to do with the prophylactic use of the sulfonamides in connection with extractions. Northrop and Crowley[20] reported some well controlled work in 1943. They confirmed the previously reported transient bacteremia following extractions. They also confirmed the findings of Burket and Burns[21] and of Hopkins[22] that, with local anesthesia, bacteremia occurs less frequently than had been the case with general anesthesia, wherein figures as high as 64 per cent had been reported, even 75 per cent in severely septic mouths. Northrop and Crowley[20] found bacteremia immediately after extraction in 13 per cent of their control cases, the blood cultures in which, just before extraction and again ten minutes afterwards, were negative. They attributed this lower incidence to the constricting effect of the adrenalin in the local anesthetic solution, giving less opportunity for bacteria from the oral cavity to enter smaller blood vessels during extraction. Others, using local anesthesia, have reported an incidence of bacteremia of 17 per cent. The fact

20. Northrop, P. M., and Crowley, M. C.: Prophylactic Use of Sulfathiazole in Transient Bacteremia Following Extraction of Teeth: Preliminary Report. J. ORAL SURG., 1:19-29, January 1943.

21. Burket, L. W., and Burns, C. G.: Bacteremia Following Dental Extractions. J. D. Res., 16:521-530, December 1937.

22. Hopkins, J. A.: Streptococcus Viridans Bacteremia Following Extraction of Teeth. J.A.D.A., 26:2002-2008, December 1939.

that such bacteremia does occur even in uncomplicated extraction with a frequency of once in every six to eight cases makes this a subject of vital importance. In the series of patients who were given 6 gm. of sulfathiazole, 1 gm. every four hours starting the afternoon before extraction, the occurrence of postextraction bacteremia was reduced to 4 per cent in the group of patients who had developed an adequate blood level of sulfathiazole by the time of operation; whereas, in the patients whose blood sulfathiazole level had not reached 3 mg. per hundred cubic centimeters by the time of extraction, the results were about the same as in the untreated group, 17 per cent showing positive blood cultures immediately after the operative procedure.

Since the majority of the organisms recovered in these postextraction cultures were streptococci, with *Streptococcus viridans* predominating, and since it is known that many cases of subacute bacterial endocarditis have followed dental extraction and other operative interference in infected areas, an oral surgeon is exposing his patient to needless risk unless this possibility is considered. Subacute bacterial endocarditis develops only on heart valves damaged by previous disease, usually rheumatic heart disease. Certainly, without the prophylactic use of one of the sulfonamides to minimize the possibility of such a complication, an extraction, or even extensive pyorrhea treatment, should not be considered in a person who has rheumatic heart disease.

We are coming to believe that sulfonamides are of value when dental extraction or similar operative work is contemplated in patients recently recovered from acute arthritis. We believe that the use of this group of drugs, other than for local application in traumatized areas after operative procedures, should be directed by a physician who is acquainted with the patient's general condition. In our own work, of the various sulfa compounds available, we prefer sulfadiazine at the present time. The aim of preoperative medication should be to attain a blood level of at least 4 to 6 mg. per hundred cubic centimeters. It seems unnecessary, from Northrop and Crowley's work, to try to maintain the blood sulfonamide level for any period after extraction, as, even in untreated cases, the blood cultures were sterile ten minutes after completion of the operation. In our own cases, we have preferred to err on the side of caution and have kept up the administration of the drug for twenty-four hours after extraction. Penicillin, when available for more general use, will no doubt be the preparation of choice for such preoperative medication, before an attack on infected foci.

UMI

PERIODONTAL CYSTS*

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A periodontal cyst, developmental in origin, is derived from odontogenetic tissue. The most common synonyms are dental root cyst, root-end cyst, radicular cyst, paradontal cyst and dentoperiosteal cyst.

Periodontal cysts, which occur in association with pulpless teeth, may have their origin in the periodontal membrane or in a granuloma. In either case, the epithelium lining the cyst is, with few exceptions, derived from epithelial remnants of the periodontal membrane. A stimulus, probably inflammation in most instances, results in proliferation of epithelium. According to Kronfeld,[1] the cyst can originate in two ways: (1) an abscess cavity in granulation tissue surrounding the root of the tooth may become lined with epithelium because of the inherent tendency for epithelium to cover raw surfaces, or (2) epithelial masses that have formed as a result of proliferation may themselves undergo cystic degeneration and be transformed into a cyst. Hill,[2] who examined serial sections of forty-two granulomas and found epithelial tissue in all of them, demonstrated epithelium in all stages of proliferation, from epithelial rests to large cystic regions, concluding that cystic regions develop within granulomas as the result of necrosis of the proliferated epithelium. It therefore appears that all granulomas are potential periodontal cysts. In a recent classification proposed by Robinson,[3] the term "periodontal cyst" has been advanced as the one of choice. In this classification, periodontal cysts have been divided in three types: (1) the radicular or dental root-apex type, which occurs at the periapex; (2) the lateral type, which is situated laterally along the root surface, and (3) the residual type, which may persist after extraction of a tooth with which it was associated or which may arise from epithelium in the region of residual infection.

A cyst may develop from residual dental infection, which was not necessarily demonstrable roentgenographically at the time of extraction. This occurred in a case observed at the Mayo Clinic in 1938. Figure 1*a*, made November 22, 1938, shows a lower first bicuspid in which putrescence of the pulp of undetermined origin was present. The patient was experiencing a great deal of pain, and the tooth had become tender to percussion, but there was little if any roentgenographic evidence of destruction of bone in

*From the Section on Dental Surgery, Mayo Clinic.

1. Kronfeld, Rudolf: Histopathology of Teeth and Their Surrounding Structures. Ed. 2. Philadelphia: Lea & Febiger, 1939, pp. 195-199.

2. Hill, T. J.: Epithelium in Dental Granulomata. J. D. Res., 10:323-332, June 1930.

3. Robinson, H. B. G.: Classification of Cysts of Tooth Bearing Bones. J. D. Res., 23:189, June 1944.

the periapical region. The tooth was extracted on the same day and the postoperative course was uneventful. Another roentgenogram, taken January 8, 1942, revealed a residual cyst in the region formerly occupied by the tooth that had been extracted (Fig 1*b*). A thin walled cyst was removed (Fig. 1*c*).

Cysts that are derived from epithelial remnants once associated with the periodontal membrane of deciduous teeth also have been classified as

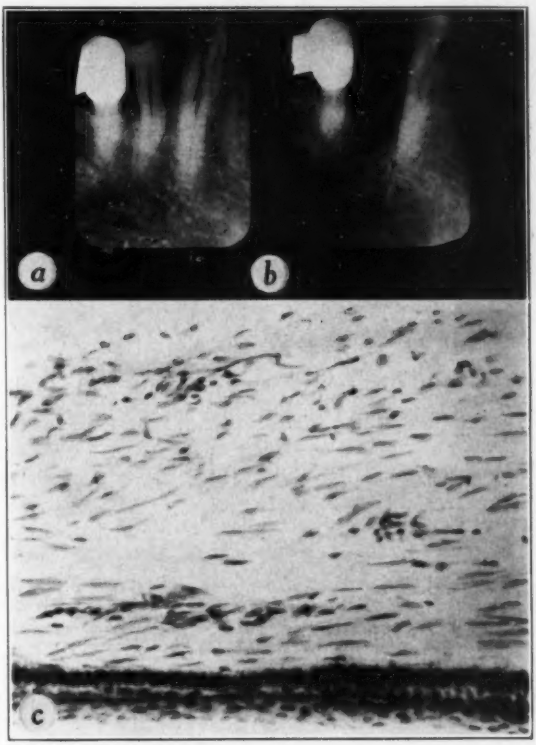

Fig. 1.—*a*, putrescent pulp in infected lower first bicuspid (November 22, 1938). *b*, residual cyst at site of extracted lower first bicuspid (January 8, 1942). *c*, portion of cystic wall lined with epithelium. (×200.)

periodontal cysts by Robinson, and rightly so. They usually have their origin in the interseptal bone and may develop many years after the loss of the deciduous teeth. One such cyst reported by one of us (E.C.S.[4])

4. Stafne, E. C.: Possible Role of Retained Deciduous Roots in Etiology of Cysts of Jaw. J.A.D.A., 24:1488-1493, September 1937.

developed after the patient had reached the age of 45. Several cysts of this nature, some of them rather large, have been observed at the clinic, but are not included in the series of periodontal cysts in this study. Figure 2 shows a relatively small one, demonstrating the site of origin. It occurred in a patient aged 49, and was first noted in a roentgenogram made July 12, 1933, as a small radiolucent region near the crest of the alveolar ridge and in the interseptal bone between the lower right first and second bicuspids (Fig. 2*a*). In a roentgenogram made August 28, 1940, the radiolucent region had increased in size and presented the typical roentgenographic appearance of a cyst (Fig. 2*b*). Removal of the cyst was incidental to

TABLE 1.—REGIONS IN WHICH FIVE HUNDRED PERIODONTAL CYSTS OCCURRED

Region	Maxilla	Mandible	Total
Incisor cuspid	212	96	308
Bicuspid	76	37	113
Molar	25	54	79
Total	313	187	500

TABLE 2.—TEETH IN WHICH THREE HUNDRED AND FORTY-NINE PERIODONTAL CYSTS HAD ORIGIN

Teeth	Maxillary	Mandibular
Central incisors	25	42
Lateral incisors	120	29
Cuspids	19	15
First bicuspids	20	19
Second bicuspids	22	7
First molars	13	13
Second molars	1	0
Third molars	1	3
Total	221	128

extraction of a lower right second molar. A photomicrograph of the lining epithelium is shown in Figure 2*c*.

This study is based on 500 consecutive periodontal cysts observed at the clinic and occurring in 469 patients, twenty-three of whom had two cysts and four of whom had three cysts.

The cysts were situated in the incisor-cuspid, bicuspid and molar regions of the maxilla and mandible. The site of the cysts is shown in Table 1, from which it is at once apparent that the cysts in the incisor-cuspid region far outnumber the cysts in other regions. This high incidence can be accounted for in a large measure by the fact that anterior teeth are more often subjected to trauma, which may lead to degeneration of the dental pulp. Anterior teeth also are retained longer on the average than are other

teeth, and this factor must be considered in remarking the incidence of many pathologic conditions associated with individual teeth. It will be noted also that 313 of the 500 cysts were situated in the maxilla and 187 of them in the mandible, a ratio of approximately 3:2. This difference is accounted for largely by the high incidence of cysts in the incisor-cuspid region of the maxilla.

In 349 instances, the root of the tooth in which the cyst had its origin was still present and, in the 151 instances remaining, the region in which

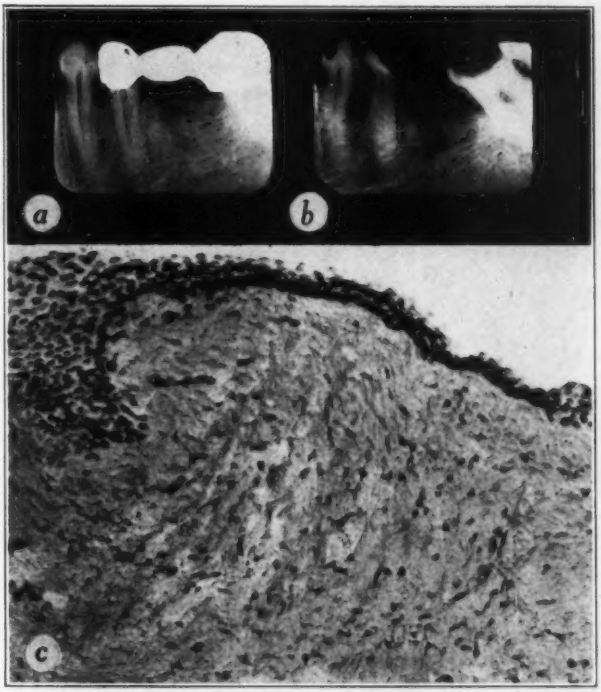

Fig. 2.—*a*, small radiolucent region near crest of alveolar ridge in interseptal bone between lower right first bicuspid and second bicuspid (July 12, 1933). *b*, radiolucent region increased in size and having assumed typical appearance of cyst (August 28, 1940). *c*, portion of cystic wall lined with epithelium. (×155.)

the cyst was situated was edentulous. The distribution of the 349 teeth in which the cysts had their origin is shown in Table 2. A rather striking finding in this tabulation is that maxillary lateral incisors account for 120, or slightly more than a third, of the 349 cysts. The frequent association of periodontal cysts with maxillary lateral incisors has been observed for a

long time; but that the relative incidence is so high is of interest. No doubt, degeneration of the pulp due to trauma accounts for a large number of them.

Another possible factor in this high incidence is the high percentage of cases of pulp degeneration after insertion of proximal fillings early in life, when the pulp chamber is large and its distance from the surface is relatively less than that of the pulp chamber in other permanent teeth that require filling. Degeneration of the pulp as a result of undetected caries in the deep invaginations of enamel on the lingual surface of the teeth or lingual pit accounts for the formation of other cysts. Fourteen cysts associated with upper lateral incisors were found in which there had been no proximal caries, but which could be accounted for by untreated caries in the lingual pit. A condition almost wholly confined to the maxillary lateral incisor is the so-called *dens in dente*, an anomaly characterized by deep invagination of enamel to form an enamel-lined cavity within the

Fig. 3.—*a*, periodontal cyst associated with dens in dente. *b*, dentoperiosteal cyst of obscure origin (June 28, 1928). *c*, same cyst June 22, 1942.

tooth. A cyst associated with this condition is shown in Figure 3*a*. The enamel lining the cavity so formed is vulnerable to caries and, as a result, there is a high incidence of periodontal cysts when this condition is present.

Sixty-one of the 349 teeth with which periodontal cysts were associated were free from caries. Only five of these were posterior teeth, the fifty-six remaining being anterior teeth, mostly upper and lower incisors. In many of these cases, there was a definite history of previous injury, and trauma was no doubt the etiologic factor in the majority of cases. A cyst that occurred in association with a pulpless, noncarious upper bicuspid and the cause of which was obscure is shown in Figure 3*b* and *c*.

Root canal therapy had been employed in ninety-six of the 349 teeth in which cysts had origin. In the 253 remaining, no such treatment had been given. This finding is significant as leading to the conclusion that the

possibility of development of a cyst on a pulpless tooth with an untreated root canal is more than two and a half times as great as the possibility of development of a cyst when the root canal has been treated. It appears that cysts develop more often on teeth in which caries extends directly into an open pulp chamber; a condition no doubt conducive to periapical inflammation and affording a continuous stimulus to proliferation of epithelium in the periodontal membrane or in a granuloma that may have formed after degeneration of the pulp.

In twenty-seven, or 6 per cent, of the 469 cases, two or more cysts were present. Figure 4 shows three periodontal cysts that were observed in one

Fig. 4.—Three periodontal cysts that occurred in one case.

Fig. 5.—Periodontal cyst that grew rather rapidly. *a*, appearance May 21, 1941. *b*, appearance July 13, 1942.

case. The tendency to occurrence of multiple cysts has been recognized. Shlefstein[5] recently reported a case in which three cysts were present. Honegger[6] reported seventeen cases in which two or more cysts occurred. He expressed the opinion that, in some cases, there was a decided individual

5. Shlefstein, I. H. L.: Multiple Cysts of Jaws. Am. J. Orthodontics, 29:452-456, August 1943.

6. Honegger, M.: Frequent Occurrence of Root Cysts in Same Patient. Schweiz. Monatschr. f. Zahnhlk., 48:917, September 1938; abstr. Year Book of Dentistry. Chicago: Year Book Publishers, 1939, pp. 440-441.

predisposition to cystic formation and that, in these cases, chronic irritation or trauma often leads to proliferation of epithelial remnants of the periodontal membrane or cystic degeneration in granulomas that may be present. He also questioned whether this tendency to cystic formation is hereditary or acquired. From a previous study by one of us (E.C.S.[7]), it appears that there is an individual tendency to granuloma. The same tendency may therefore exist to cyst formation since granuloma is more often a stage in the development of a cyst. The occurrence of multiple cysts is, in many instances, a result of retention of teeth in which there is extensive uncontrolled and untreated caries after degeneration of the dental

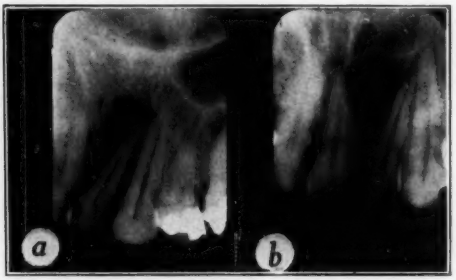

Fig. 6.—Increase in size of periodontal cyst in fifteen years. *a*, appearance in 1925. *b*, appearance in 1940.

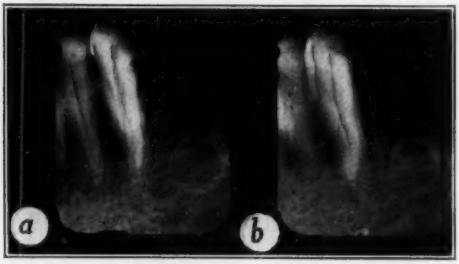

Fig. 7.—Periodontal cyst that did not change in size in eight years. *a*, appearance in 1935. *b*, appearance in 1943.

pulp. A high percentage of granulomas develop in teeth so involved, and these granulomas must be considered potential epithelial-lined cysts.

An attempt was made to determine the relative size of the cysts by measurements taken from the roentgenograms. It was found that the cysts associated with teeth which were still present averaged 1.3 cm. in diameter and those occupying edentulous regions averaged 1.6 cm. in diameter.

7. Stafne, E. C.: Dental Conditions Found in Duodenal Ulcer and Arthritis. D. Cosmos, 71:404-408, April 1929.

This finding was, in a measure, predictable, since it must be assumed that, in all probability, the cysts in edentulous regions were, on the average, of longer duration.

Eighty-eight of the 500 cysts in this series were removed at the clinic and microscopic sections were made of all of these. All of the cysts were lined with squamous epithelium with the exception of one, which was lined with ciliated columnar epithelium. It was situated in an edentulous molar region of the maxilla and the epithelium may have had its origin in invagination of epithelium from the lining of the maxillary sinus. This cyst was reported by Lovestedt.[8]

Roentgenograms of thirty-six cysts were made at intervals ranging from fourteen months to fifteen years after first observed. In fifteen of the thirty-six instances, it was noted that the cyst had increased in size; in seventeen instances, there was no change in size or roentgenographic appearance; in three instances, the cyst had decreased in size, and, in one instance, it had disappeared completely.

Fig. 8.—Small cyst surrounded by concentric layers of bone.

Figure 5 shows a cyst of an upper left lateral incisor that grew rather rapidly. Another cyst, somewhat similar, is shown in Figure 6. The roentgenogram in Figure 6*a* was made fifteen years before the one in Figure 6*b*. Since no intervening roentgenograms were made of this cyst, it was not possible to determine how rapidly the cyst had grown or whether it was still undergoing active growth. Regardless of the rate of growth, development probably was continuous. In some instances, a cyst does not reach its maximal size until the cortical plate has been perforated and drainage to the external surface has been established. In the majority of cases, growth is limited, and once there is a cessation of growth, probably only rarely is there further increase. This is suggested by roentgenographic observations made over periods of from two to twelve years of seventeen cysts that did not increase in size. Most of the cysts in which growth had

8. Lovestedt, S. A.: Cysts of Jaws Lined with Ciliated Columnar Epithelium. Am. J. Orthodontics, 30:16-22, January 1944.

apparently ceased were of more than average size. A few had not attained any appreciable size. One of these is shown in Figure 7.

A reduction in size or complete disappearance of a dentoperiosteal cyst when there has been no surgical interference is not unusual. It probably occurs most frequently when there is progressive caries, with extrusion or eruption of the root to which the cyst is attached. When the root is exfoliated or extracted, degeneration and disappearance of the cyst may follow. In other instances, such a cyst may become acutely infected. A fistulous opening to the surface may be established, affording continuous drainage. As a result, the cyst may be destroyed and the region formerly occupied by the cyst be replaced by bone. More rarely, cysts may disappear when there is no demonstrable communication with or drainage to the

Fig. 9.—Spontaneous degeneration of periodontal cyst. *a*, appearance August 24, 1932. *b*, appearance August 3, 1942.

outside surface. One should not conclude that drainage does not exist, for it may be so slight that it cannot be detected either by the patient or on thorough clinical examination. Cysts have been surrounded by concentric layers of cancellated bone extending some distance away from them. This peculiar bony pattern is suggestive of a cyst which has been reduced in size. Such a condition is shown in Figure 8, in which a small residual cyst is situated in an upper bicuspid region. Around this cyst is a series of radiopaque concentric lines forming a circle appreciably larger than the small cyst that was removed. It can be assumed that the cyst at some time had been as large as the circle formed by the concentric layer at the periphery. The presence of the concentric circles suggests

that the reduction in size may have been brought about by intermittent or interrupted drainage. All cysts that decrease in size do not present these concentric circles.

Cysts may disappear completely for reasons that are obscure. Such a cyst (Figure 9) occurred in a woman aged 55 who was suffering from hypertension. She first was seen in 1932 and, in the course of a general examination, a roentgenogram revealed the characteristic image of a cyst in the left molar region of the mandible, a cyst which no doubt had its origin in the missing second bicuspid (Fig. 9*a*). A roentgenogram made in 1942 (Fig. 9*b*) revealed that the cavity formerly occupied by the cyst had been replaced completely by bone. On questioning the patient, it was found that, during an interval of ten years, no surgical measures had been taken either to drain or to remove the cyst. There had been no demonstrable drainage and no discomfort or other symptoms had been perceived by the patient. Why the cyst had disappeared completely is problematic. Perhaps there was drainage so slight that it could not be detected; or the epithelial lining may have undergone degeneration and, as a result, the bony cavity was replaced by bone. That the condition present was not a periodontal cyst, but a lesion associated with polycystic disease or some other generalized disease in which the roentgenographic appearance of the lesions was similar to that of a cyst, was considered a possibility. The general physical examination did not reveal generalized disease of bone.

COMMENT

Periodontal cysts occur more frequently in the maxilla than in the mandible, the ratio being approximately 3:2. The difference is largely accounted for by the large number of cysts associated with maxillary anterior teeth, particularly lateral incisors.

A significant finding is that periodontal cysts develop more than two and a half times as often on roots of pulpless teeth with untreated root canals as on roots that have had the root canals treated.

The growth of most dentoperiosteal cysts is limited. A rather large number of them continue to grow, encroaching on adjoining teeth, with resultant extensive destruction of bone. In such instances, surgical procedures necessary for eradication are involved and a long period of postoperative care is required. Therefore, removal of all small cysts is indicated at a time when operative and postoperative care and complications are at a minimum.

In some instances, well-developed dentoperiosteal cysts decrease in size even though there is clinically no demonstrable communication with the outside. They may on rare occasions disappear completely.

UMI

EARLY AND LATE TREATMENT OF GUNSHOT WOUNDS OF THE JAWS IN FRENCH BATTLE CASUALTIES IN NORTH AFRICA AND ITALY*

JOHN MARQUIS CONVERSE,† M.D., New York, N. Y.

This paper is based on work done during the year 1943-1944 at the request of the French authorities for plastic surgical care of French battle casualties.

(The treatment of these maxillofacial cases was administered at the Algiers Plastic and Maxillo-Facial Center in collaboration with Brig. Gen. A. Romey, consulting oral and dental surgeon to the French Army, and his two assistants, Lt. P. Lemaitre and Lt. H. Guidi. Capt. M. Peri assisted in most of the operations reported in this paper. The French and American Red Cross assisted greatly in furnishing equipment and supplies for the performance of the work. A number of photographs and drawings were made under the direction of Capt. Carl D. Clarke of the Third Detachment Museum and Medical Art Service, United States Army.)

The treatment of gunshot wounds of the jaws may be divided into three distinct periods. The first, or early, phase, which extends from the time of injury to one or two days after injury, is the most critical for the patient. This is the period of asphyxia, loss of blood, shock, pain and mental depression.

After this critical first period, the patient enters the second phase, during which, in accordance with the severity of the case, the treatment of the patient consists in the immobilization of the bone fragments by means of ligatures or splints, to increase his comfort and to control infection, which may result in pulmonary complications or secondary hemorrhage. The late primary suture of the wounds may be carried out in this prereconstructive phase.

The third period is the reconstructive phase proper, which follows healing of the tissues and often evacuation of the patient to the zone of the interior. At this time, reconstructive plastic operations, often interrupted by periods of convalescence, are started.

THE FIRST, OR EARLY, PHASE

The arrest of hemorrhage by clamping and packing, the relief of respiratory obstruction by protraction of the tongue and the treatment

*Read before the Inter-Allied Medical Congress, Algiers, February 21, 1944 and before the American Association of Plastic Surgeons, Philadelphia, May 25, 1944.

†Temporarily (1943-1944), consultant in plastic surgery and major, French Army Medical Corps; captain (MC) AUS.

of shock by the relief of pain and by transfusions of plasma and whole blood are essential, immediate life-saving measures. These measures having been taken, further treatment should be postponed whenever possible until the patient can be put in the care of a specialized maxillofacial team.

Experiences in North Africa and Italy corroborated previous reports of the inadvisability of primary suture of gunshot wounds of the face. These wounds of compound comminuted fractures of the jaws are characterized by marked contusion and contamination. Because of the extent of the tissue injury, the wounds rapidly become edematous, and bacteria find a favorable medium for their growth in the devitalized tissue, contaminated by foreign bodies of all sorts and by oral and nasal secretions.

Fig. 1.—Left: Appearance of Moroccan soldier when seen two weeks after compound fracture of maxilla by shell fragment. Right: Appearance after immobilization of fracture. As shown in Figure 2, late primary suture of the wound restored the normal contour of the face.

While débridement of facial wounds should be sparing, surgical cleansing should strive to remove small devitalized tags of tissue, loose and detached bone fragments lying in the wound and foreign bodies. Detached flaps, hanging by gravity, should be supported by dressings held by bandages.

The most important point in the early treatment of gunshot wounds is to provide immobilization of the remaining fragments by simple means, such as ligature wires or elastics. Reduction of the fragments is easy at this stage. The restoration of the normal anatomic position of the soft tissues

is aided when displaced fragments of bone are restored to their normal position of dental occlusion. Large gaping wounds into which displaced fragments are projecting become smaller and restoration of the normal position of the remaining structures facilitates future reconstruction work.

THE SECOND, OR PRERECONSTRUCTIVE, PHASE

Problems in feeding the patient may have arisen and the use of nasal tubing may be necessary, but, after a few days, most patients learn to feed

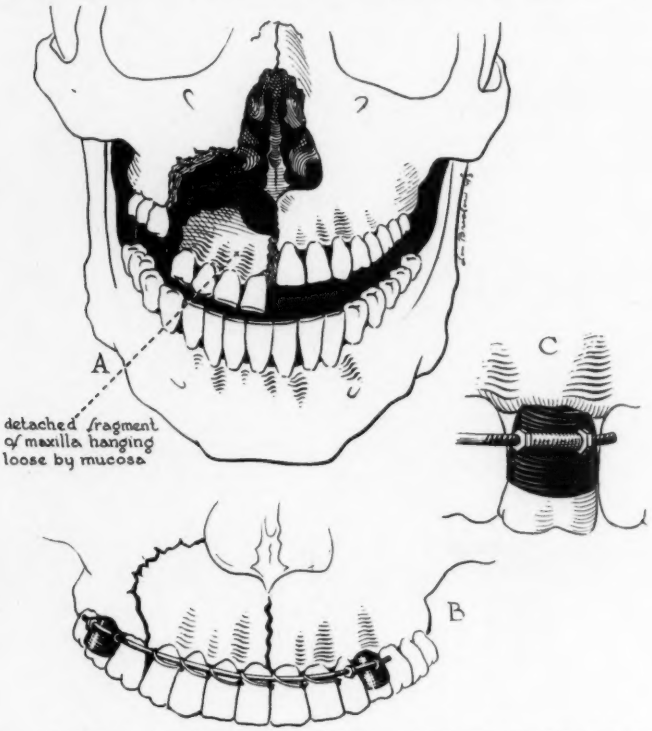

Fig. 2.—Completely detached fragment of bone reduced and immobilized by fracture band before late primary suture was carried out.

themselves adequately. At this stage, definitive means of immobilizing the bone fragments (splints, arches and bands) will be used to insure complete immobilization of the fragments. The next step in the treatment consists of controlling wound infection by cleansing the wound by irrigation, by the use of pressure dressings and by administering bacteriostatics (sulfonamides, penicillin). Within from seven to fourteen days, the wound may be-

come clean, pink and devoid of edema. Late primary suture (Kazanjian) can then be carried out so as to restore the continuity of the soft tissues. The late primary suture is the next most important step after immobilization of the bone fragments. It is essential that wound suture be carried out only after definitive methods of immobilizing the bone fragments have been applied so as to avoid rupture of the sutured wound by intra-oral manipulation. (Figs. 1 and 2.) To carry out wound suture before immobilization of the bone fragments in correct position has been assured will lead to the displacement of these fragments into vicious positions, necessi-

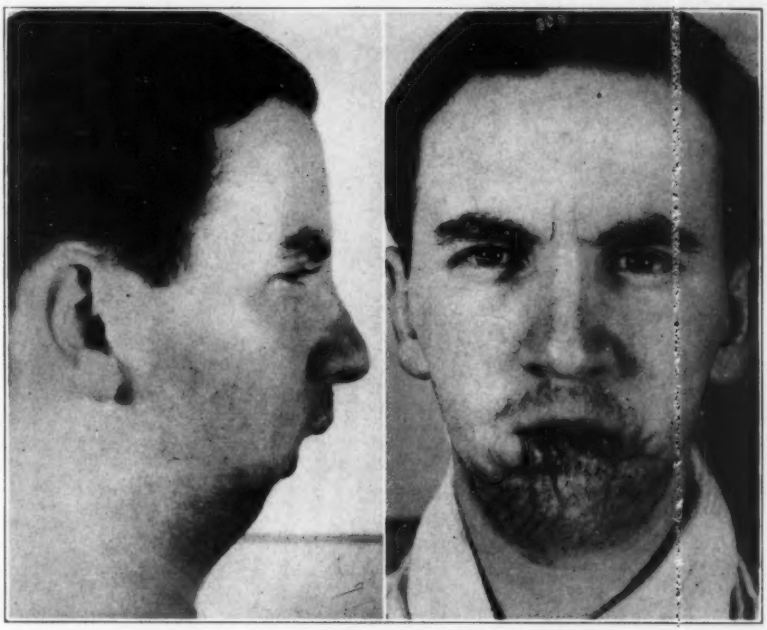

Fig. 3.—Appearance of patient after remaining soft tissues had been sutured (primary) under tension causing medial displacement of mandibular fragments.

tating an added step in the reconstruction: the preliminary replacement of the structures in their anatomic position. (Figs 3-7.)

In order to preserve the anatomic position of the tissues, the lip or cheek should be supported by a vulcanite or acrylic mold, held by the splint. In the same way, a mold will prevent the closure, by contraction, of a full-thickness, through-and-through defect of the cheek or lip. Thus, distortion is avoided. Whenever possible, in such cases, the skin edge should be sutured to the mucous membrane edge. The plugging of such defects by

a mold or splint also helps to arrest the loss of saliva, which may be causing considerable fluid loss. (Fig. 5.)

Certain problems concerning the treatment may need to be considered during this phase: the question of extraction of teeth in the line of fracture, of external drainage, of late primary suture, of external fixation and of internal interosseous wiring.

1. Extraction of Teeth in the Line of Fracture.—Most of the suppurat-

Fig. 4.—Left: Casts showing medial displacement of remaining fragments. Right: Casts showing corrected position of fragments after resection of all scar tissue and replacement of soft tissues in anatomic position.

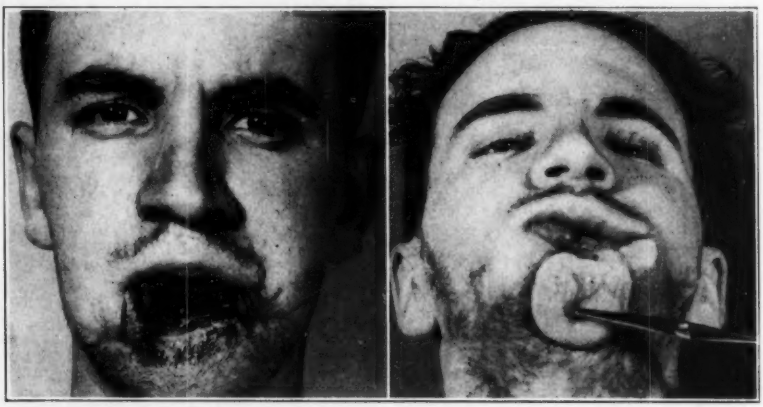

Fig. 5.—Left: Tissues replaced in anatomic position. The true defect now becomes apparent. Right: Simple mold helping to reduce saliva loss and to increase comfort of patient.

ing fractures seen were caused by the presence of a tooth left in the line of fracture. As a general rule, any tooth in the line of fracture, deprived of its blood supply, should be extracted before necrosis of the pulp leads to a suppurative process. In patients who must travel through a long evacuation line before reaching a maxillofacial center, the observance of

this rule is particularly important. It is necessary to compare the complete difference in clinical handling of such a patient with that of a patient who has already reached a maxillofacial center from which evacuation will not be precipitated. Under the latter conditions, the preservation of a tooth in the line of fracture, under armed and expectant vigilance, in order to enhance the treatment may be carefully considered. It is to be observed that a tooth may be placed in the line of the fracture, but not be deprived of its blood supply because its apex is surrounded by bone. (Fig. 8.) The

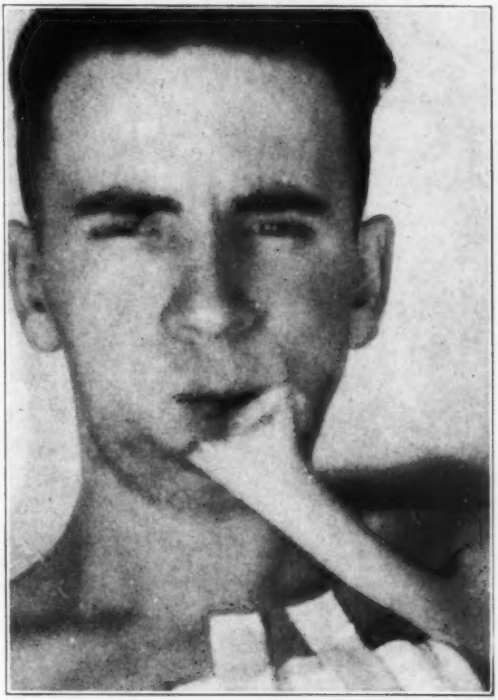

Fig. 6.—Upper portion of lower lip reconstructed by means of local flaps from cheeks. The tubed pedicle is utilized to restore the inner lining and outer covering of the chin.

preservation of a tooth in the line of fracture may prevent the upward displacement of a posterior fragment until the fracture is partially or completely consolidated. (Fig. 9.) In such cases, the oral administration of sulfadiazine (penicillin was not available) (from 3 to 6 gm. daily) was carried out for from ten to fourteen days and extraction of the tooth in the line of fracture was postponed, if possible, until after consolidation.

In all fractures that are consolidating, it is preferable to postpone the extraction of teeth until after consolidation to avoid traumatizing the binding granulation tissue and causing displacement of the fragments. (Fig. 10.)

2. *The Use of External Drainage.*—External through-and through drainage was utilized for one purpose only: the evacuation of collected pus. This procedure represents, to my mind, the only indication for employment of a drain as I have been incapable of seeing the clinical rationale of so-called "early drainage" as a prophylactic measure before the collection of pus, unless it be for evacuation of a large hematoma. In four patients who developed signs of early infection (acute tenderness, redness, subperiosteal thickening), the intra-oral administration of sulfadiazine (from

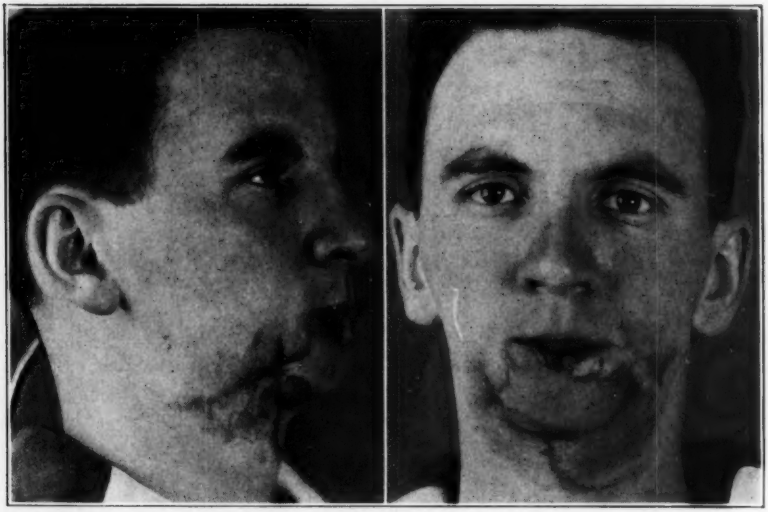

Fig. 7.—Appearance of patient three weeks after placing of bone graft.

3 to 6 gm. daily) was followed by a subsidence illustrated by a rapid fall of the temperature.

3. *Late Primary Suture of Wounds Over Extensively Comminuted Fractures.*—In extensively comminuted fractures of the mandible, it was noted that consolidation of the numerous fragments occurred readily if the latter were covered by soft tissues and if the adjacent fragments of the mandible were immobilized. Late primary suture of wounds leaving uncovered such comminuted fragments appeared to prevent the sequestration of these denuded fragments. (Fig. 11.)

4. *The Use of External Fixation.*—External fixation by means of an ap-

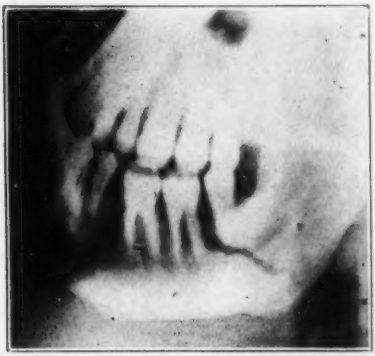

Fig. 8.—First and second molars with apices unexposed, which were preserved in order to permit wire ligature fixation of fragment. The third molar was extracted four weeks later. Sulfadiazine, 3 gm. daily, was administered by mouth for fourteen days.

Fig. 9.—Prevention of upward displacement of posterior fragment by presence of third molar tooth, which was extracted twenty-fifth day. Sulfadiazine was administered orally (5 gm. daily) for twelve days.

pliance, modified from appliances previously used[1,2] (Figs. 12-13) was employed in four of 168 maxillofacial cases. In contradistinction to the indiscriminate use of external fixation appliances, often by inexperienced operators, observed both in this country and in the theaters of operations, indications for the use of external fixation were carefully considered.[3] External

1. Converse, J. M., and Waknitz, F. W.: *J. Bone & Joint Surg.*, 24:154, 1942.
2. Clouston, T. H., and Walker, F. A.: *Brit. D. J.*, 74:147, March 19, 1943.
3. Waldron, C. W.; Kazanjian, V. H., and Parker, D. B.: Skeletal Fixation Treatment of Fractures of Mandible. J. ORAL SURG., 1:59, January 1943.

Fig. 10.—Comminuted gunshot fracture of mandible. A molar tooth buried among the fragments was extracted after complete consolidation of the fracture.

Fig. 11.—Left: Comminuted compound fracture of mandible caused by contact with mortar shell fragment. There was extensive sequestration of the denuded fragments of bone. Center: Appearance of patient two months later after loss of two-thirds of ascending ramus and one-third of horizontal branch. Deviation of the mandible is prevented by a flange. Right: Appearance of patient after reconstruction of ascending ramus and horizontal branch using iliac bone graft according to method described in Figures 32-34.

fixation was utilized to immobilize edentulous bone fragments during bone grafting (Figs. 12-13), to immobilize edentulous mandibular fragments in a gunshot wound with loss of substance of the mandible (Figs. 14-18) and to maintain the position of a posterior edentulous fragment after osteotomy to elongate the mandible.

5. *The Use of Internal Interosseous Wiring.*—Interosseous wiring with

Fig. 12.—Left and center: German prisoner of war wearing external fixation appliance, immobilizing fragments of compound fracture in edentulous mandible with loss of substance. Right: Pressure dressing applied to wound.

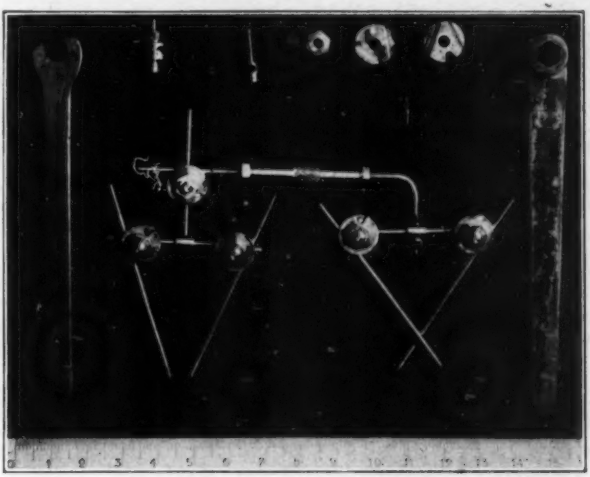

Fig. 13.—Algiers type of external fixation appliance designed for use by French Army. The jackscrew permits variations in distance between the pin units.

stainless steel after open reduction proved a direct and satisfactory method of treating fractures of the mandibular angle with marked displacement of the posterior edentulous fragment. (Figs. 19-21.) It is believed that this method advantageously replaces external fixation methods, in those cases in which simpler methods, such as pressing a forked wire upon the posterior fragment, are not sufficient, particularly in unreduced fractures with early fibrous union. Two fine (size 40) stainless steel wires twisted into a cable were used in a figure-of-eight ligature. (Figs. 19-21.)

THIRD, OR RECONSTRUCTIVE, PHASE PROPER

It must be emphasized that reconstructive surgical procedures are greatly simplified when adequate treatment is given to the patient during the first two phases. Consequently, a great deal of the credit for the final result belongs to the surgeon who gave this early care.

When the remaining fragments are not immobilized in the normal position of dental occlusion, and when the soft tissues are sutured over a defect,

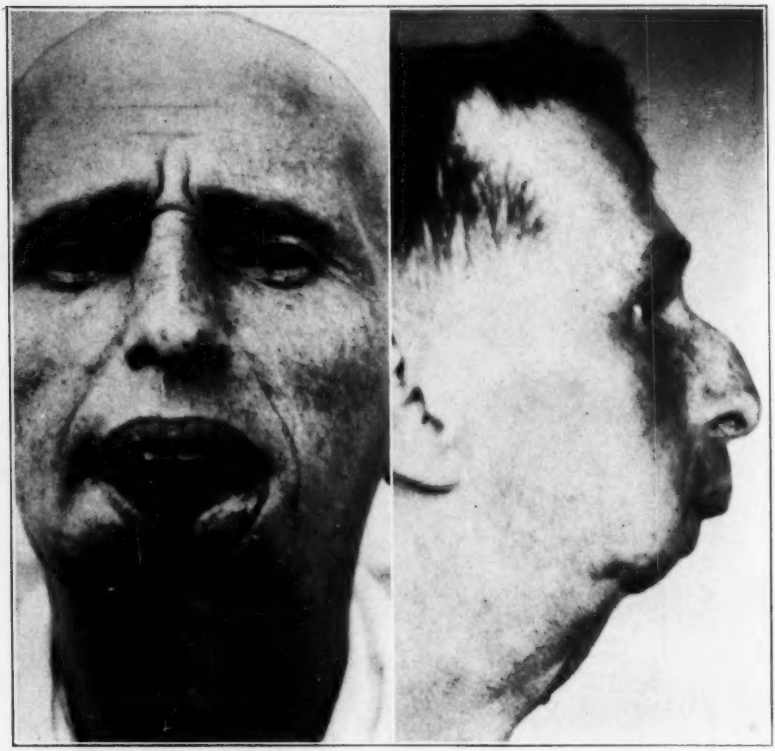

Fig. 14.—Left: Seaman wounded by bomb fragment, sustaining loss of anterior two-thirds of mandible. Right: Profile view of patient. (See also Figures 15-18.)

this causing distortion, considerable disturbance in the normal anatomic position of the tissues will result. The pull of the intervening scar tissue will cause a medial displacement of the fragments, which may be very great when a large amount of the intervening bone has been lost, and thus a marked deformity result. (Figs. 3-7.) When such a vicious displacement of

bone fragments is well established, only surgical excision of the scar tissue and liberation of the fragments will permit the latter to be replaced in their anatomic position. (Figs. 3-7.)

After gunshot wounds, reconstruction may require the restoration of soft tissues and of bone. The first step in the reconstruction of such cases must insure a restored lower lip, consisting not only of a cutaneous covering and of muscle, but also of an inner lining. The second step will be the correction, by a bone graft, of the mandibular defect. The third step is the construction of a sulcus that will furnish an alveolar process permitting the wearing of a dental prosthesis. The reconstruction should not only

Fig. 15.—Left: Soft tissue defect filled by bitemporal scalp flap (made by Captain Peri). Right: Appearance of patient after bone grafting described in Figure 18. Immobilization of the remaining edentulous fragments was assisted by external fixation.

correct the deformity produced by a loss of tissue, but also establish fully the function of the mandible.

1. *Reconstruction of Soft Tissues.*—Soft tissue defects of the mandibular region resulting from gunshot wounds are most frequent in the region of the symphysis. Patients may present extensive destruction in this region, surviving the injury because no essential structures are involved. The higher in the face the injury occurs, the slighter the chances of survival. In

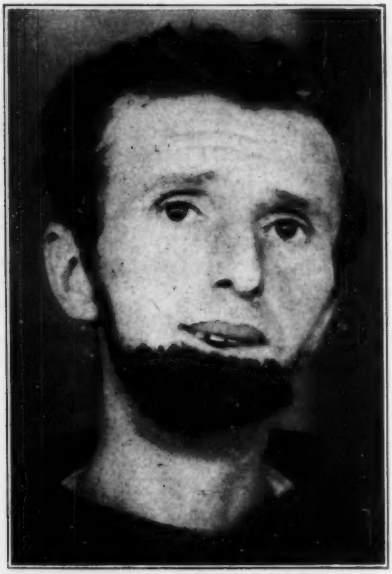

Fig. 16.—Appearance of patient before resuturing of lower lip.

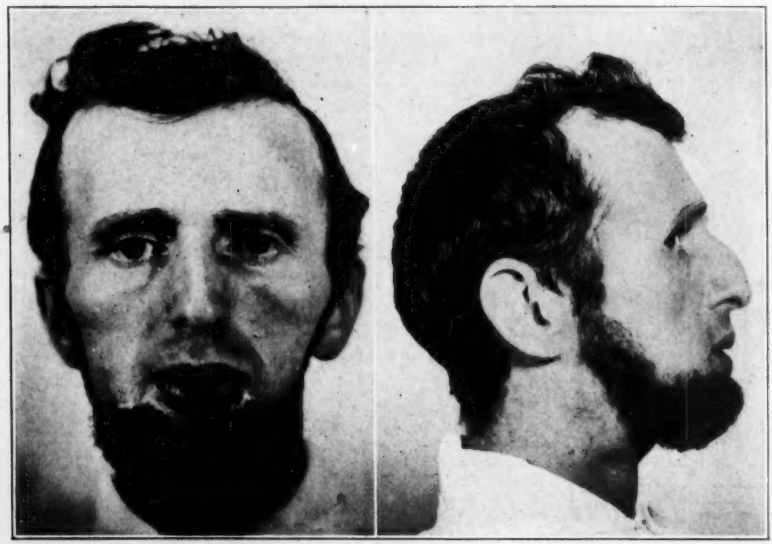

Fig. 17.—Final result in case shown in Figures 14, 15, 16 and 18. Wearing of a beard is less objectionable to a European than to an American.

the same way, the chances of survival diminish as the injury occurs farther back because of the danger of injury to the large vessels.

The repair of partial defects of the lower lips can be achieved by many types of local flaps borrowed from the cheeks, the neck or even the upper lip.

The main principles in the reconstruction of extensive defects of the lower lip are the restoration of a mucous membrane vermilion border and of muscle tissue in the lip, of an inner lining and of an outer covering, borrowed, whenever possible, from the adjacent skin.

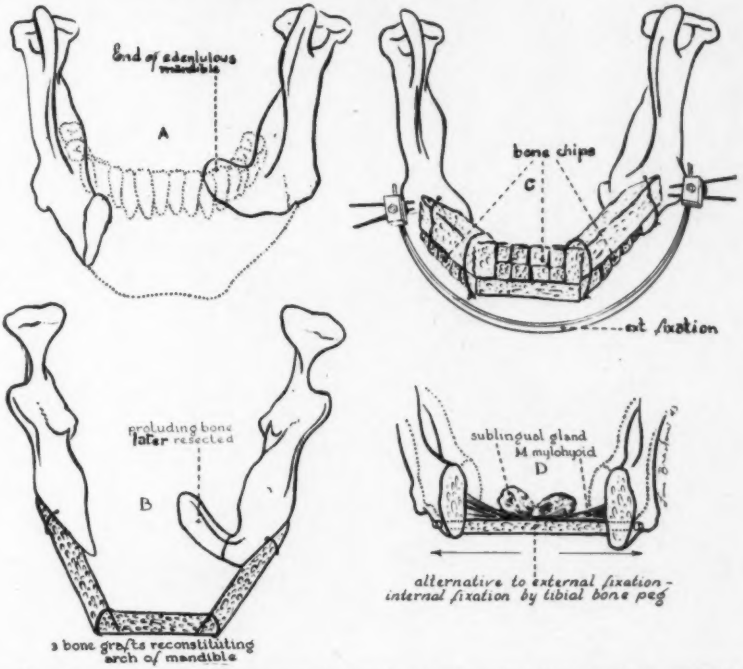

Fig. 18.—*A*, *B* and *C*, diagrammatic drawings representing bone grafting employing three pieces of iliac bone wired together, the remaining fragments being fixed with stainless steel wires. Small bone chips were packed around the grafts. *D*, alternative method for fixing edentulous mandibular fragments by passing bone peg beneath mylohyoid muscle. (Ginestet.)

The vermilion border and some muscle tissue can be brought into the new lip when the latter is reconstructed by advancing or rotating the tissues situated laterally. When it is necessary to utilize flaps of skin from a distance, the upper portion of the lip can be made by using local flaps. The rest of the lip and the chin can be reconstructed by means of the distant

Fig. 19.—Marked forward displacement of posterior edentulous fragment present when patient was first seen in Algiers Center three weeks after fracture caused by bomb explosion.

Fig. 20.—Anatomic reduction obtained by open reduction and internal interosseous wiring.

flap. (Figs. 3-7 and 14-18.) Whenever possible, in extensive defects of the lower lip, the inner lining should be provided by the distant flap, while the outer covering can be obtained from wide rotation flaps (Kazanjian). This procedure is particularly desirable in men, because of the necessity for replacing hair-bearing skin. Flaps of scalp necessitate the wearing of a beard because the stiff scalp is so dissimilar to the surrounding tissues. (Figs. 14-18.) When loss of tissue of the cheek and side of the face occurs over the site of a gunshot wound of the mandible, tissue replacement

nearly always can be obtained by means of rotation flaps from the neck. (Figs. 11 and 24.)

2. *Reconstruction of Bone.*—Before bone grafting can be undertaken, the defective area must be provided with well-vascularized nonscarred soft tissue, all evidence of sepsis should be absent and complete immobilization of the remaining fragments of the mandible during and after bone grafting must be assured.

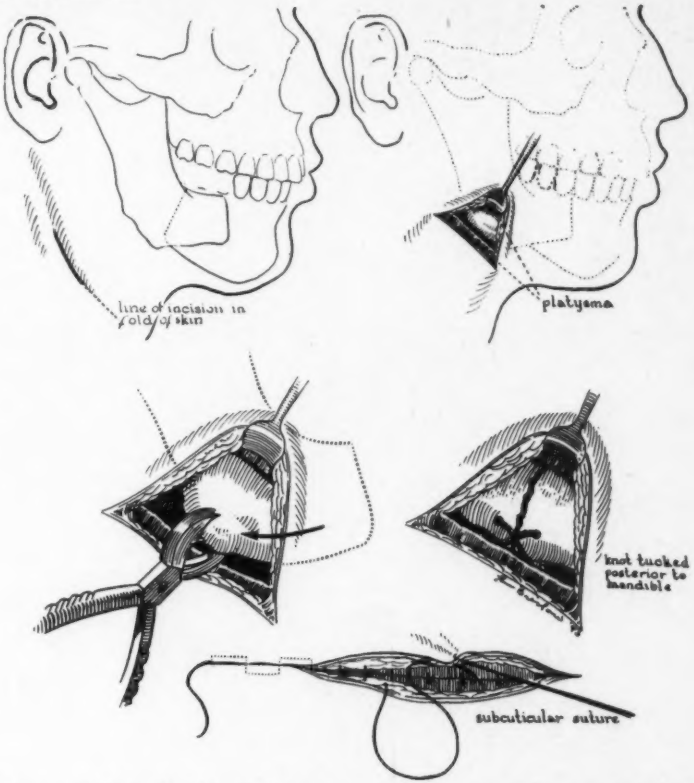

Fig. 21.—Technic of wiring angle fracture. An incision is made in a cervical skin fold. The angle of the mandible is exposed and reduced with a heavy bone-grasping forceps. Reduction is maintained by a figure of eight twisted wire passed through a drill hole in each fragment. The skin incision is carefully sutured with a subcuticular suture.

The means of immobilizing the remaining fragments of the mandible will vary according to whether the fragments are provided with teeth or are edentulous.

(a) Interdental fixation by means of splints constitutes the best means

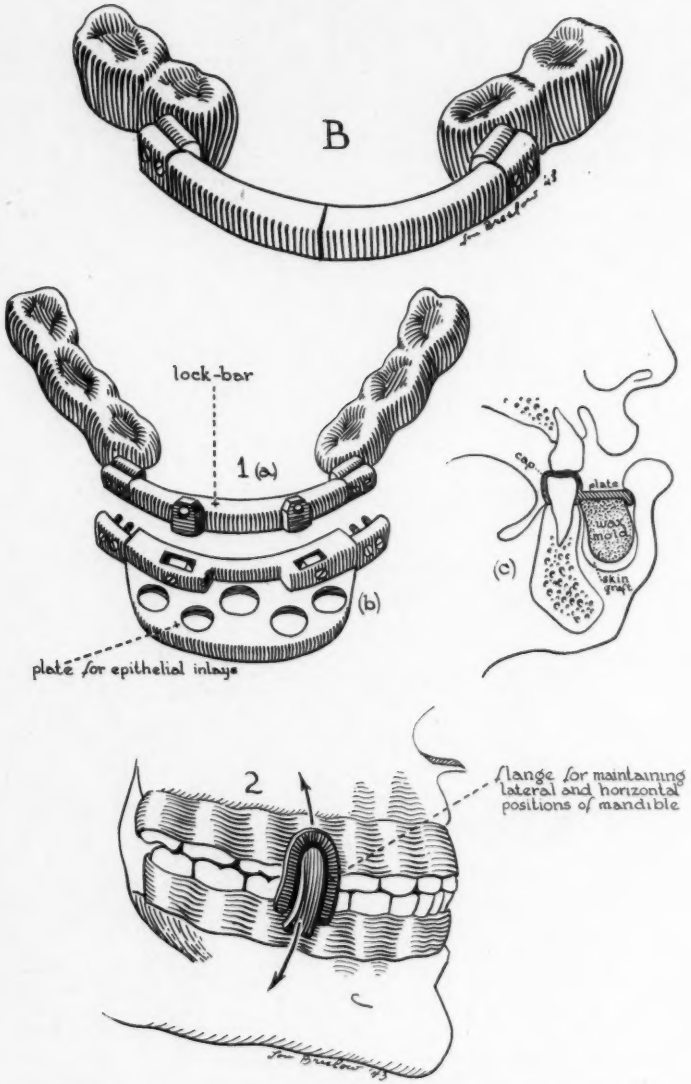

Fig. 22.—Splints used for bone grafting. *B*, British type silver cast cap splint. *1*, cast splint holding tray for epithelial inlay. *2*, flange used to prevent lateral deviations of mandible. These splints were satisfactory for bone grafting under conditions of limited supplies and equipment.

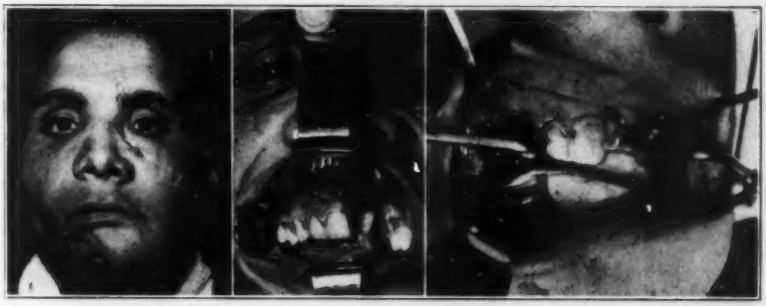

Fig. 23.—Soldier wounded by machine gun bullet. Comminuted compound fracture of the maxillae and mandible went untreated for twelve days during the invasion of Corsica, with resultant displacement of the fragments (left and center and Fig. 25). The maxilla was immobilized by cranial fixation to a head cap and silver cast splints were applied to the upper teeth and the lower fragments. After removal of the fibrous tissue between the lower fragments through an external incision and the replacement of the fragments in occlusion with the upper teeth, an intermediary lock bar was made (right and Fig. 25).

Fig. 24.—Cranial fixation maintained with Kirschner wires and universal joints used in external fixation apparatus shown in Figures 12, left, and 13.

of fixation of the fragments and permits early movement of the temporomandibular joints. From the surgeon's standpoint, the design of the splint is not so important as long as it is sufficiently strong to provide absolute

immobilization without breaking. (Fig. 22.) During the bone grafting operation, when shaping of the ends of the remaining fragments may be necessary, it is advisable to establish intermaxillary fixation. In this manner, the mandible is immobilized during the operation, and some of the stress is removed from the splint, so that there is less chance of breaking or unsealing the splint during the operation. Wires are placed before the operation

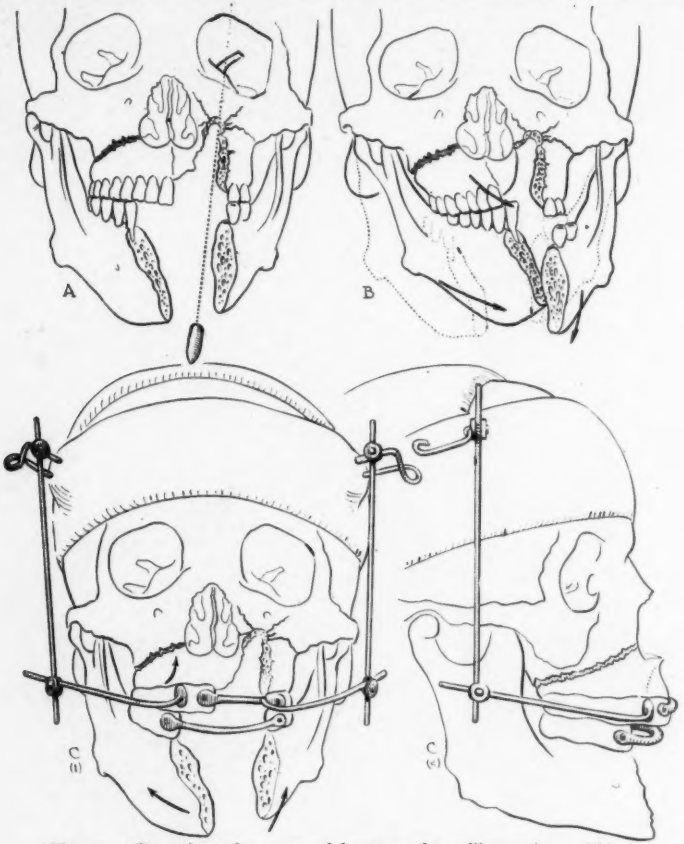

Fig. 25.—Comminuted compound fracture of maxillae and mandible.

and, after the intratracheal tube has been introduced, the intermaxillary wires are tightened. The splint can be constructed so as to provide an anchorage point for a mold, which will be utilized later to maintain the contour of the lower lip or to hold in position a skin graft. (Fig. 22.) When the remaining fragments are in unfavorable positions and when the cor-

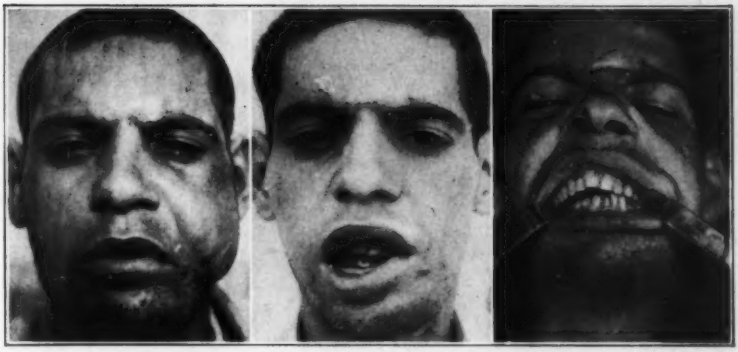

Fig. 26.—Left: Loss of soft tissue and of lower two-thirds of left ascending ramus of mandible and posterior one-third of horizontal branch from wound by shell fragments. Center: Soft tissue defect repaired by rotation flaps from neck. The ascending ramus has been reconstructed by the technic shown in Figure 32. Right: Deviation of mandible to left resulting from loss of ascending ramus.

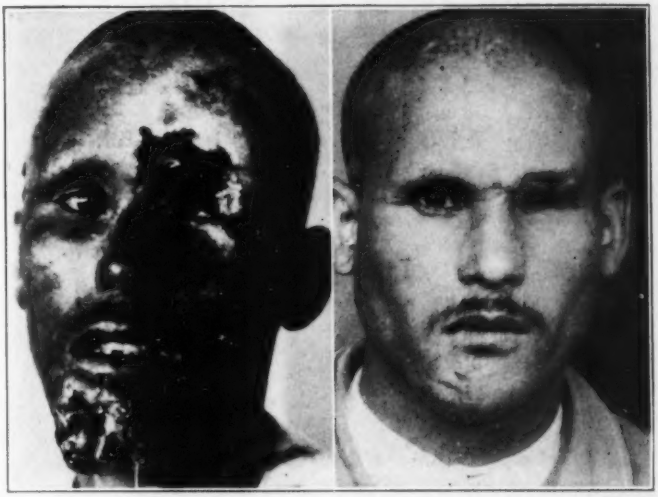

Fig. 27.—Wounds in left frontal region and in symphysis of mandible from shell fragments (left). A late primary suture of the wounds was made and the frontal wound was closed by a rotation flap (right).

rect positions of the fragments cannot be predetermined accurately, an intermediary lock-bar, which unites two separate splints, can be made after the repositioning of the fragments. (Figs. 23-25.)

(When a large bone graft is required and when the remaining fragments

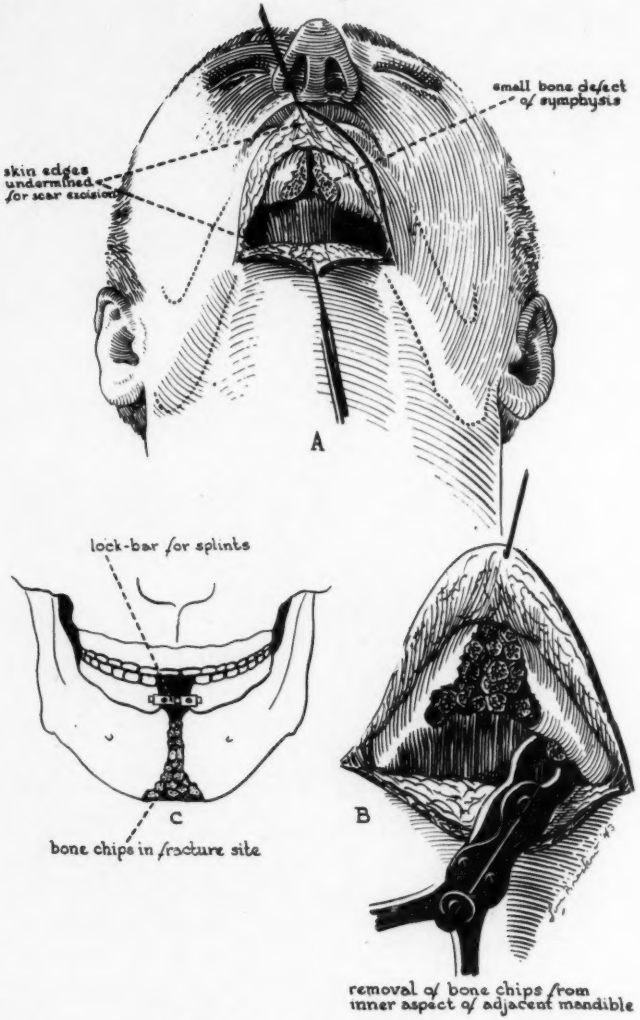
small bone defect of symphysis
skin edges undermined for scar excision
A
lock-bar for splints
C
bone chips in fracture site
B
removal of bone chips from inner aspect of adjacent mandible

Fig. 28.—Fibrous union of mandible in which bone grafting was effected by use of chips of adjacent bone.

present few teeth on which to anchor a splint, the latter may be constructed in two segments, united by a removable lock bar. To relieve the stress on the splint, the lock bar may be removed before the operation and each

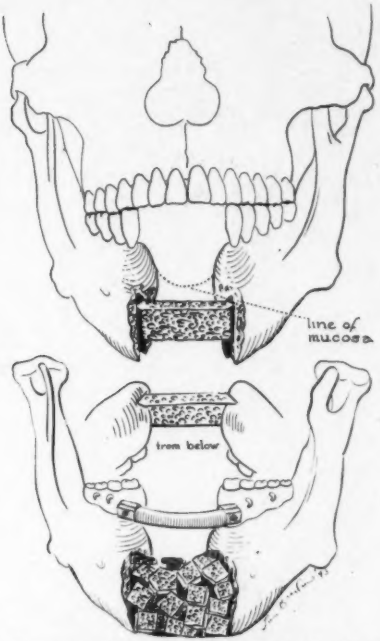

Fig. 29.—Technic of bone graft strut surrounded by bone chips. A bone graft is wedged between the ends of the remaining bone fragments and bone chips are then packed around the strut until the desired contour is obtained.

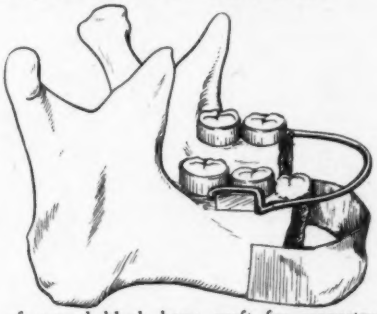

Fig. 30.—Technic of carved block bone graft for reconstruction of symphysis of mandible. The tin pattern is shaped and fitted.

fragment wired to the teeth of the maxilla. After the operation, the lock bar can be replaced in position.)

(b) External fixation by means of converging pins is valuable in immobilizing edentulous fragments. (Figs. 12-18.)

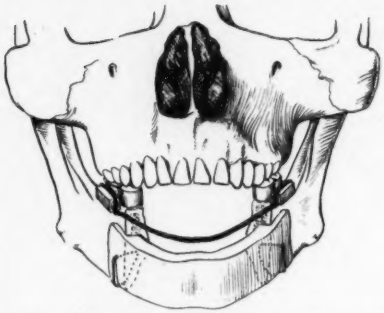

Fig. 31—Iliac bone graft carved to shape and wired in place.

Fig. 32.—Technic of reconstruction of ascending ramus following gunshot wounds. The iliac bone graft is removed from the inner aspect of the opposite anterior superior iliac spine.

(c) Internal fixation can be obtained by the graft itself when it is wired in position with stainless steel wire. In two cases presenting edentulous fragments, this internal fixation was assisted by external fixation. (Figs. 14-18.) Tantalum was used in one case to achieve internal fixation and immobilize numerous bone grafts. The tantalum was removed one year later because its upper edge had cut through the oral mucosa, with ulceration and infection resulting.

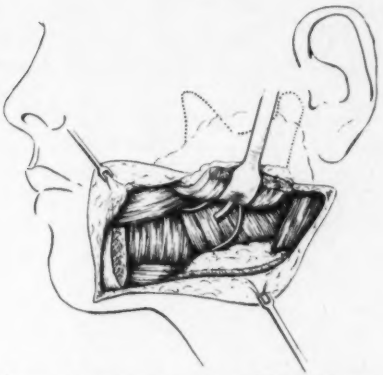

Fig. 33.—Line of cleavage between masseter and internal pterygoid muscles revealed by identification of lingual and inferior alveolar nerves and nerve to mylohyoid muscle. The parotid gland containing the facial nerve is reflected upward.

Fig. 34.—Angulated iliac bone graft wired to horizontal branch of mandible and resting on lateral surface of remaining portion of ascending ramus.

BONE GRAFTING

Twelve bone grafts were made to the mandible. Seven bone graft operations were performed in the region of the symphysis, three in the region of the horizontal ramus and two for the reconstruction of the ascending ramus and the angle of the mandible. The slightest nonunion presented a gap 1 cm. wide. The largest defect corrected involved the whole of the horizontal portion of the mandible, representing an arch 22.5 cm. in length.

TECHNIC OF BONE GRAFTING

The grafts were all taken from the iliac bone, from the internal aspect

of the ilium after elevation of the periosteum and of the muscles which arise from the crest of the ilium. After removal of the bone grafts and careful hemostasis, the wound was sutured with silk, plane by plane, without drainage.

The bone grafts were applied in different ways:

1. *Chip or Fragmented Bone Grafts.*—The bone removed from the ilium was cut into pieces of variable size from about 1 cm. square to larger fragments. After the ends of the remaining fragments had been freshened, these bone chips were packed solidly into the defect. Bone chips can be borrowed from the surrounding bone for the repair of small defects. (Fig. 28.)

2. *Bone Strut Surrounded by Bone Chips.*—The extremity of each fragment was freshened and grooved in a triangular fashion. (Fig. 29.) A piece of spongy iliac bone, each end of which was triangular, was wedged

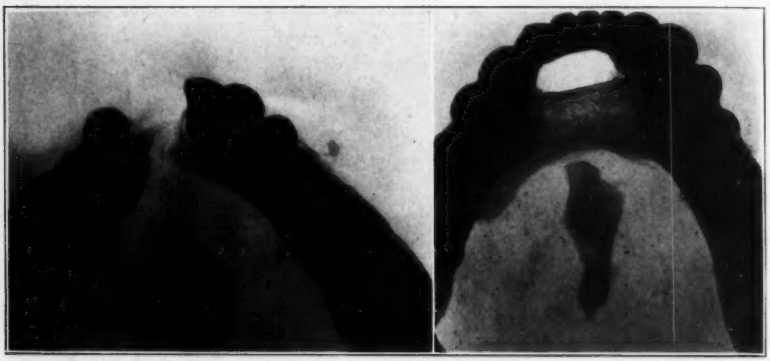

Fig. 35.—Left: Medially displaced fragments. Right: Bone graft of symphysis four months after operation.

into the triangular groove at the extremity of each fragment. (Fig. 29.) The graft is then surrounded by numerous bone fragments so as to mold the contour of the new symphysis. (Fig. 29.)

3. *Carved Block Bone Grafts.*—After preparation of the ends of the remaining fragments, a piece of tin plate is modeled *in situ* so as to reproduce the outer contour of the desired restoration area and to serve as a pattern for carving a contour-restoring block of iliac bone, which is wired in place. (Figs. 30-31.) In most cases in which bone grafting is carried out in the region of the symphysis, it is necessary to add more bone later, to restore the chin to normal contour.

Reconstruction of the Ascending Ramus, the Angle and the Horizontal Ramus of the Mandible.—In two cases, reconstruction of this part of the mandible was accomplished by using the inner half of the bone of the

anterior superior spine of the iliac bone. (Fig. 32.) The inner half of the spine itself constituted the angle of the mandible. (Fig. 32.)

The graft is introduced into an intermuscular space made between the masseter and the internal pterygoid muscle. In this manner, the parotid gland containing the facial nerve is avoided. The lingual, inferior alveolar and mylohyoid nerves, situated on the lateral surface of the internal pterygoid muscle, are clearly seen (Fig. 33), designating the line of separation between the masseter and the internal pterygoid muscle.

The graft is wired anteriorly to the remaining portion of the horizontal ramus and posteriorly rests on the lateral surface of the remaining ascending ramus. (Fig. 34.) Such reconstruction of the ascending ramus of the mandible after skin plastics by rotation flaps provided a stable dental occlusion as well as a marked esthetic improvement.

RESULTS

The average time for consolidation of the bone grafts was about two months. At this time, on x-ray examination, the grafts still appeared well decalcified. Toward the fourth month, most of the grafts resumed a normal appearance. The time of final consolidation was often more difficult to estimate exactly, varying from two to three months. Most bone grafts were "sticky" at the end of six weeks. In one case, the immobilizing splint broke on the eighth day after bone grafting and a purulent discharge appeared four days later. This mobilization of the graft was at least partially responsible for the suppuration. Three grams of sulfadiazine was administered daily to the patient. The lower fragments were wired to the upper teeth in normal occlusion. At the end of ten days, suppuration ceased. At the end of two months, the wiring was removed as the graft appeared to be consolidated. A few days later, rotation of the fragments occurred, necessitating correction by elastic traction. This case was particularly unfavorable because the fragments were in unsatisfactory position before the grafting and tended to resume their former position.

Reconstruction of the Alveolar Process.—The final step in reconstruction, following that involving the soft tissues, and consolidation of the bone graft, consists in restoring the buccal sulcus. In this manner, an alveolar ridge will be formed that will permit wearing a prosthesis. The principles have remained unchanged since they were established by Waldron and others at Sidcup in 1918. The splint used to immobilize the fragments carries a tray which holds a mold around which has been wrapped a skin graft, raw surface outward. (Fig. 22.)

In edentulous cases, the mold was anchored by stainless steel wires passed down through the skin and tied over pieces of gauze.

UMI

COMBINED PENTOTHAL SODIUM-NITROUS OXIDE-OXYGEN ANESTHESIA IN ORAL SURGERY

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San Diego, Calif.

While pentothal sodium alone, or with oxygen, is suitable for short operations, pentothal sodium in combination with nitrous oxide-oxygen is, we believe, a much more desirable anesthetic for use in oral surgical procedures requiring more than the minimum of time.

ADVANTAGES

By this method, the minimal amount of pentothal sodium is used, the margin of safety is greatly increased, recovery is much more rapid and the length of stay in the office is greatly shortened.

Induction is quick and pleasant for the patient. The absence of struggling during induction, the quietness of the patient during the anesthetic period and the ease with which anesthesia is maintained conserve the energy of the anesthetist and operating team, and are conducive to good surgical technic.

The absence of struggling during induction makes this method of anesthesia very desirable in cases of pregnancy. Two of our patients were considered to be past full term.

A high percentage of oxygen may be used, to prevent the undesirable degree of tissue anoxia that so often accompanies nitrous oxide-oxygen anesthesia.[1] Thus, the dangers of cerebral damage are avoided and a wider margin of safety is provided for patients with cardiovascular involvement or lowered vitality from other causes.

There is no explosion hazard.

Nausea is rare.

SYSTEMIC EFFECTS

The reaction of patients to the intravenous injection of pentothal sodium varies widely, depending on individual tolerance.

After intravenous administration of pentothal sodium, the respiration is depressed and arrest of respiration may occur.

Although the blood pressure usually drops from 5 to 20 mm. of mercury, there may occasionally be a rise in blood pressure. In patients with hypertension, the decrease may be as much as from 30 to 60 mm.

The pulse rate frequently increases as much as thirty beats per minute.

1. Courville, C. B.: Untoward Effects of Nitrous Oxide Anesthesia. Mountainview: Pacific Press Publishing Association, 1939.

Electrocardiographic observations by Thomas,[2] Betlach and Dry,[3] and Caraway,[4] made before, during and after pentothal sodium anesthesia, indicate no harmful effect on the myocardium or conductive system.

Thomas[2] reports that there is little or no change in the blood urea. The blood sugar is slightly raised. There is no hemolysis, change in clotting time or change in red cells, white cells or differential count or hemoglobin determination. Recently, Pender and Lundy[5] have demonstrated that hemoglobin concentration may decrease as much as 18.7 per cent.

Caraway[4] reports no diminution of liver function.

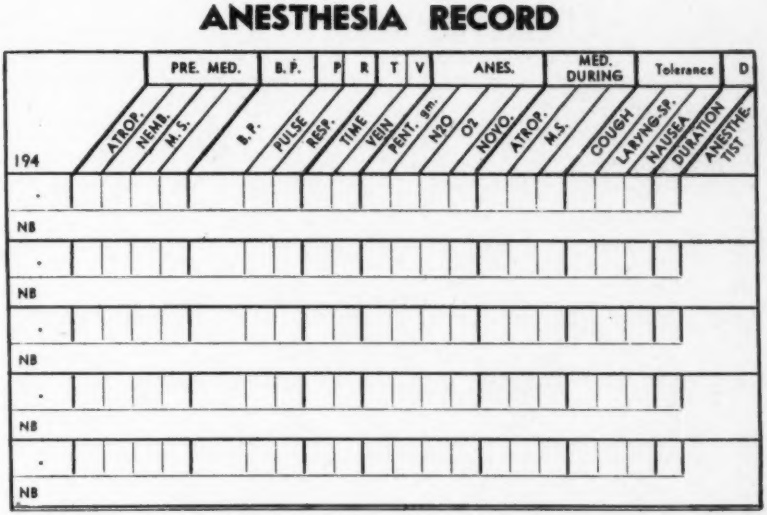

Fig. 1.—Form suitable for recording data relative to anesthetic procedure.

Pentothal sodium is thought to be detoxified in the liver, blood and muscle tissue,[6] but its fate in the body is unknown.

2. Thomas, G. J.: Clinical and Laboratory Observations on Intravenous Anesthesia. Anesth. & Analg., 17:163, May-June 1938.

3. Betlach, C. J., and Dry, T. J.: Effects of Pentothal Sodium on Electrocardiogram of Patients with Essential Hypertension. Proc. Staff Meet., Mayo Clinic, 13:189, March 23, 1938.

4. Carraway, B. M.: Pentothal Sodium with Nasal Oxygen: Report of 3,810 Cases. Anesth. & Analg., 18:359, September-October 1939.

5. Pender, J. W., and Lundy, J. S.: Changes of Concentration of Hemoglobin During Anesthesia in Man and in Animals. Anesthesiology, 5:163, March 1944.

6. Adams, R. C.: Intravenous Anesthesia. New York: Paul B. Hoeber, Inc., 1944, p. 473.

INDICATIONS AND CONTRAINDICATIONS

Contraindications to the use of pentothal sodium are essentially relative. Those that are usually accepted as definite are: (1) dyspnea; (2) marked cardiac disease with decompensation; (3) limitation of respiratory motion, and (4) marked anemia, "if the erythrocyte count is less than 2,000,000 and the hemoglobin is less than 40 per cent, unless the dose of the intravenous anesthetic agent is small and oxygen is administered simultaneously."[7]

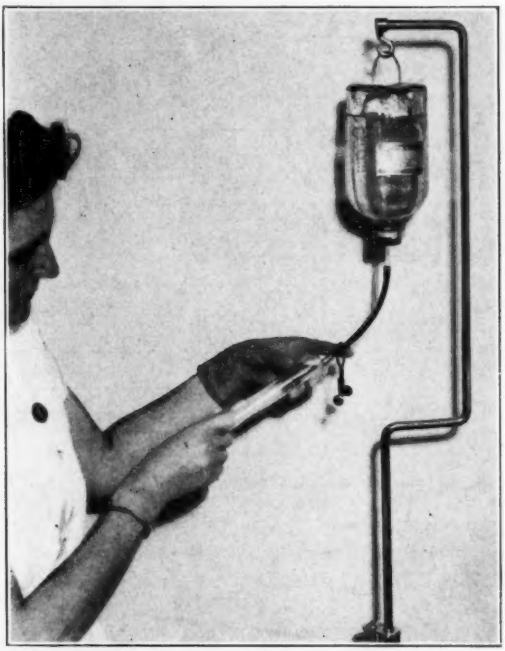

Fig. 2.—Filling syringe from liter bottle containing 2.5 per cent pentothal sodium. The solution in the bottle should be agitated, when allowed to stand for any length of time, to prevent increased concentration of the solution at the bottom of the bottle.

The deaths reported by Patterson[8] emphasize the desirability for avoiding the use of barbiturates for anesthesia in patients with marked arteriovasculorenal disease and the necessity for having efficient means of resuscitation available.

7. Lundy, J. S.: Clinical Anesthesia. Philadelphia: W. B. Saunders Co., 1942, p. 503.
8. Patterson, R. L.: Case Reports of Fatalities Following Intravenous Anesthesia. Anesth. & Analg., 20:225, July-August 1941.

One of the borderline contraindications to the use of intravenous anesthesia is deep infection in the floor of the mouth and neck. Weese[9] has demonstrated experimentally that accidents may be due in part to the presence of a hypersensitive carotid sinus reflex, pressure over the carotid sinus and failure to allow adequate time for sufficient depth of anesthesia before operating.

Williams (surgeon, Lahey Clinic) and Marcus (anesthetist, Boston City Hospital[10]) consider intravenous anesthesia as the method of choice in Ludwig's angina, when it is carefully used according to their definite method of procedure, which takes into consideration:

1. Preliminary incision and preparation for possible tracheotomy to the point of exposing the trachea, under local anesthesia.
2. Premedication with atropine (one seventy-fifth grain one-half hour before operation.)
3. Slow induction.

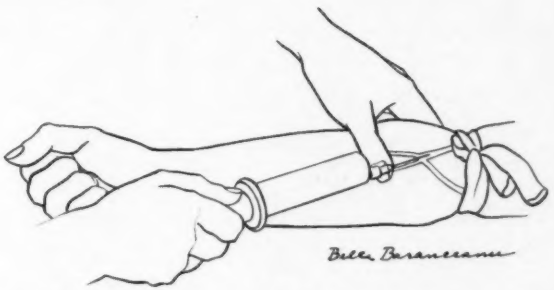

Fig. 3.—One-inch Penrose drain applied as a tourniquet close to area of venipuncture, immobilizing vein from above. The anesthetist's thumb stretches the overlying skin and immobilizes the vein from below. Venipuncture is accomplished, a small amount of blood is aspirated into the syringe and the needle is advanced in the vein. Clenching the hand makes the vein stand out more prominently.

4. Sufficient depth of anesthesia before incision or manipulation of the neck.
5. Administration of nasal oxygen, at least 3 liters per minute, to be increased as necessary.
6. Prompt intravenous administration of additional atropine, one one-hundred-fiftieth grain and/or metrazol, 3 cc., during anesthesia as required for suppression of laryngeal spasm and support of respiration.
7. Maintenance of patency of the airway by supporting the jaw and pulling the tongue forward.

9. Weese, Hellmut: Concerning Mechanism of Anesthesia Accidents in Sublingual Phlegmons. Anesth. & Analg., 18:15, January-February 1939.

10. Williams, A. C., and Marcus, P. S.: Choice of Anesthesia in Ludwig's Angina. Anesth. & Analg., 20:160-170, May-June 1941.

8. Maintenance of adequate depth of anesthesia during operation to keep reflexes abolished.

9. Tracheotomy if necessary.

10. Postoperative administration of oxygen for from twelve to twenty-four hours.

11. Provision of a bedside tracheotomy kit, to be held in readiness.

Certainly one should proceed with extreme caution in all cases showing involvement of the floor of the mouth and neck.

After the experimental work of Adriani,[11] it was thought for some time that the use of pentothal sodium might be contraindicated when sulfonamide therapy was being employed. We therefore used evipal soluble in these cases. Later, we administered pentothal sodium to patients receiving therapeutic doses of sulfanilamide, sulfathiazole or sulfadiazine, without observable ill-effects.

Intravenous anesthesia should not be administered when ample means for resuscitation are not quickly available. It should not be attempted in patients who do not present suitable veins. The skill of the anesthetist often

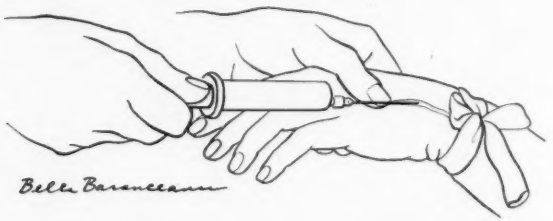

Fig. 4.—Tourniquet close to site of venipuncture of vein on dorsum of hand, skin stretched and suction created in syringe by slight forward pressure on barrel of syringe with thumb and index finger of anesthetist's right hand so that venipuncture and aspiration of blood are simultaneous. (Lundy's method of holding syringe.)

determines the suitability of the vein. Those who are inexperienced in general anesthetic procedures should not administer intravenous anesthetic agents. Small amounts of pentothal sodium, supplemented with a high percentage of oxygen plus nitrous oxide, may be safely given, in many cases, to patients with impaired vitality, who might otherwise be denied the advantages of the intravenous agent.

CHILDREN

In the literature, it has been frequently stated that the use of pentothal sodium is contraindicated in children under 10 years of age. For this reason, we previously deferred its use in such cases. During the past few years,

11. Adriani, John: Effects of Anesthetic Drugs upon Rats Treated with Sulfanilamide. J. Lab. & Clin. Med., 24:1066, July 1939.

we have been using pentothal sodium for children with increasing frequency, until now, combined with oxygen and nitrous oxide, it is our anesthetic of choice. Although our experience with children under 10 years of age is still limited (276 cases), the present indications are that a 2.5 per cent solution of pentothal sodium, in small doses, is well tolerated. One of these patients was 2 years, 7 months of age; another 2 years, 5 months. The age of the youngest, in which 4 cc. of a 1.25 per cent solution was used, was 1 year and 3 days. It should be understood that at present we are neither advocating nor discouraging the use of pentothal sodium for induction in these extremely young children. We are stating our experience for such value as it may have. The intravenous anesthesia was well tolerated by all of these children.

PREOPERATIVE CONSIDERATIONS

As with any case in which general anesthesia is to be used, an evaluation of the anesthetic risk should be made. The medical history is obtained and the patient's physician is consulted. The blood pressure, pulse and respira-

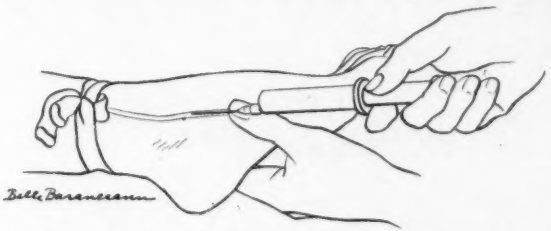

Fig. 5.—Venipuncture of great saphenous vein similarly accomplished (compare Figure 4); showing immobilization of vein and stretching of skin.

tion are recorded. (Fig. 1.) When cardiac irregularities are found, the patient is referred to a medical consultant for further consideration.

PREMEDICATION AND INSTRUCTIONS TO PATIENT

For short operations, no premedication may be necessary. In most cases, patients should have the benefits of premedication, to decrease psychic trauma, control the secretion of mucus and saliva, speed induction and maintain a desirable depth of anesthesia. Much less of the anesthetic agent is required.

It is important to adapt premedication to the individual case.

Atropine sulfate one one-hundredth grain (0.00065 gm.) may be given alone or in combination with morphine sulfate one-sixth to one-quarter grain (0.01-0.016 gm.), either intravenously, just before the anesthetic, subcutaneously one-half hour before or by mouth one-half to three-quarters of an hour before administration of the anesthetic.

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Atropine one one-hundredth grain (0.00065 gm.) with pentobarbital sodium one and one-half grains (0.1 gm.) may be given by mouth three-quarters of an hour before operation.

Our "usual premedication" for adult patients in good health, for whom operative procedures are to be prolonged, consists of administration of pentobarbital sodium 1½ grains (0.1 gm.) with atropine one one-hundredth grain (0.00065 gm.) by mouth one and one-half hours before, and morphine sulfate one-fourth grain (0.016 gm.) with atropine sulfate one one-hundredth grain (0.00065 gm.) three-quarters of an hour before the anesthetic. The use of pentobarbital sodium prior to administration of morphine seems to decrease the incidence of nausea from the use of morphine.

Atropine, as a parasympathetic depressant, is used to prevent laryngospasm. Its action in this respect is not always satisfactory, but its effect in checking the secretion of mucus and saliva is highly desirable. The use of atropine also decreases the activity of the carotid sinus reflex.

When a patient is suffering intense pain, quick relief and desirable premedication is afforded by the intravenous administration of morphine

Fig. 6.—Venipuncture in small veins. It is advantageous to turn the bevel of the needle down.

sulfate one-sixth to one-fourth grain (0.01-0.016 gm.) with atropine one one-hundredth grain (0.00065 gm.). The hypodermic tablets are dissolved in 2 cc. of sterile distilled water and injected slowly during a period of two minutes.[12]

Because of undue respiratory depression, it is well to avoid or greatly restrict the use of morphine for premedication in the very young, elderly or frail.

Usually, children are presented without previous preparation, and immediate operation is requested. In these cases, pentothal sodium has been administered without premedication with satisfactory results. When possible, children should have the benefit of premedication. A pleasant means of such medication is elixir of pentobarbital sodium, which contains one-fourth grain (0.016 gm.) of pentobarbital sodium per dram. To this is added atropine sulfate. Children 3 years of age may be given 3 drams of the elixir one-half hour before administration of the anesthetic. Each dose

12. Betlach, C. J.: Intravenous Use of Morphine Sulfate for Analgesia. Proc. Staff Meet., Mayo Clin. 12:733, November 17, 1937.

should contain atropine sulfate one one-hundred-fiftieth grain (0.00043 gm.). Atropine one one-hundred-fiftieth grain (0.00043 gm.) alone may be given. It will be found that children have an unusually high tolerance for barbiturate premedication[13] and that the foregoing dose will in many cases be inadequate. The dosage must be individualized.

When, in cases of hypotension, the systolic blood pressure is found to be 100 mm. of mercury or less, neosynephrine one-fourth to one-half cubic centimeter of a 1 per cent solution (0.0025-0.005 gm.) is injected intramuscularly to produce a more desirable degree of blood pressure.

As with other general anesthetics, the stomach and bladder should be empty. The patient is also requested to discontinue smoking several hours before administration of the anesthetic. The use of tobacco seems to increase the resistance of the patient to the anesthetic agent. Because of the usual lack of postanesthetic nausea, patients who have recently eaten may occasionally be given pentothal sodium. It is important to remember that the aspiration of vomitus may be fatal.

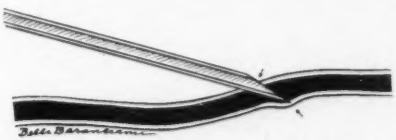

Fig. 7.—Bevel turned up. There is an increased tendency to perforate the walls of the vein, thus producing a hematoma, and on injection, to deposit the anesthetic solution extravenously.

The patient must be in the custody of a relative or other responsible person during the preanesthetic and postanesthetic periods.

TECHNIC OF ADMINISTRATION

The rate of detoxification of pentothal sodium varies with the method of administration, the rate being higher after a single initial intravenous injection, and lower after injection of a similar amount by slow intravenous infusion.[14]

When intravenous anesthesia is used only occasionally, the anesthetic solution is freshly prepared just before administration. One gram of the powder is dissolved in 40 cc. of double or triple distilled water. This gives approximately a 2.5 per cent solution, which we prefer to the 5 per cent solution formerly used. Use of the 2.5 per cent solution decreases the incidence of laryngospasm, has little or no local reaction if injected

13. Reference 6, p. 23.

14. Kohn-Richards, Richard, and Grimes, Clyde: Detoxification of Barbiturates and Influence of Method of Administration; Demonstrated with Nembutal and Pentothal. Anesth. & Analg., 18:139, May-June 1939.

extravenously, is less irritating to the vein and offers a wider margin of safety. The use of a long needle of large caliber facilitates mixing the solution and loading the syringe.

As we are using a large quantity of pentothal sodium daily, it has been found desirable to prepare a liter of the solution at a time. Twenty-five grams of pentothal sodium is dissolved in 1 liter of normal saline solution. From this liter bottle (Fig. 2), a large number of 20 cc. syringes are filled, capped and placed on a large sterile tray ready for immediate use as needed. A syringe with eccentric tip is preferred. Agitation of the anesthetic solution by inversion of bottle, just before filling the syringes, mixes the solution, which becomes of increased concentration at the bottom of the bottle on standing.[15] The solution of pentothal sodium seems to be fairly stable. It has been used with satisfactory results several days after preparation.

A 23-gage needle is used. The caliber of this comparatively small needle is adequate for sufficiently rapid injection of the anesthetic solution and has

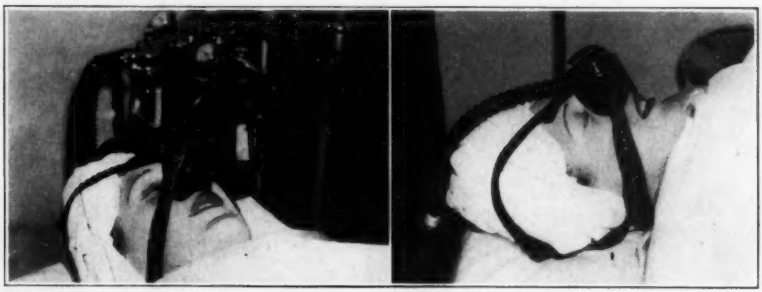

Fig. 8.—Stabilization and close adaptation of nasal inhaler made possible by use of four-tailed retention strap. (Modification of conventional nasal inhaler devised by O. K. Bullard.)

the advantage of facilitating successful venipuncture in the smaller veins.

A suitable vein in the antecubital fossa, dorsum of the hand, wrist, foot or ankle is selected and the tourniquet applied. A 1-inch Penrose drain provides a much more comfortable tourniquet than the usual rubber tubing. The skin is thoroughly sponged with alcohol, the vein is immobilized with the thumb or index finger and venipuncture is made. (Figs. 3-5.) The needle bevel may be up for large veins, but should be turned down for small veins. (Figs. 6 and 7.) Injection of the external jugular vein can be made when other suitable veins are not available.

For the "average" patient in good health, the first 5 to 10 cc. (0.125-0.250 gm.) is injected rather rapidly. The amount and speed of the injection must be varied to suit the type of patient being anesthetized. In

15. Reference 7, p. 501.

accordance with the degree of susceptibility of the patient, as indicated by the rapidity with which consciousness is lost, and changes in respiration and loss of reflexes occur, an additional 5 to 10 cc. (0.125-0.250 gm.) is more slowly injected. If the operation is to be quickly accomplished, the amount of solution used is kept to the minimum, only light anesthesia being necessary. When the operation is to be prolonged, slightly more of the anesthetic agent is injected than might otherwise be used. The total amount of the 2.5 per cent solution used seldom exceeds 20-30 cc. (0.5-0.75 gm.).

As soon as the patient no longer responds to questioning or when the corneal reflex is absent, a suitable nasal inhaler is secured in place with a four-tailed retention strap (Fig. 8) and the anesthetic machine is set to deliver 25 per cent oxygen and 75 per cent nitrous oxide. The comparative percentage may be varied to suit the needs of the individual case.

The desired amount of pentothal sodium having been injected, the needle

Fig. 9.—Two-towel drape secured with towel clips to four-tailed retention strap; mouth prop in place. During anesthetic and operative procedures, the mandible is supported in an anterior position and stabilized by the anesthetist.

is withdrawn from the vein and the anesthetic procedure is continued as in nitrous oxide-oxygen anesthesia.

The mouth prop is now inserted (Fig. 9), the tongue pulled forward and a gauze pack placed to prevent blood and débris from being aspirated, and to aid in holding the tongue forward to prevent mechanical respiratory embarrassment. The gauze pack should be kept well forward to avoid stimulation of the pharyngal reflex, which is usually active.

The respiration, which becomes quite shallow, must be carefully observed during the entire anesthetic period. During operative procedures, the mandible is supported in the anterior position by the anesthetist. It is of the utmost importance to maintain the patency of the airway. This point can-

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not be overemphasized. Gordon[16] calls attention to the fact that resistance to the respiratory effort, during either inspiration or expiration, may cause a marked increase in blood pressure, anoxia, pulmonary edema, respiratory failure and cardiac collapse.

When the patient shows signs of returning consciousness and the depth of anesthesia becomes inadequate for the completion of the operation, an additional 5 to 10 cc. (0.125-0.250 gm.) of the intravenous anesthetic agent is injected rather than to attempt to deepen the anesthesia by increasing the percentage of nitrous oxide, which, being a relatively weak anesthetic agent, is not suitable for increasing the depth of anesthesia. This, of course, involves the reinsertion of the needle in the vein. Its use is essentially to assist the action of the intravenous agent. Except for the increased explosion hazards, incidence of nausea and more prolonged recovery period, the use of a more powerful inhalation anesthetic agent, such as ethylene or cyclopropane, would be preferred to nitrous oxide.

Balanced anesthesia, a term coined by Lundy, is maintained by manipulation of the oxygen and nitrous oxide percentages, keeping the oxygen percentage high at all times, and the intermittent injection of additional small amounts of pentothal sodium as needed.

For the occasional rugged individual who, because of high tolerance, is extremely resistant to the anesthetic agents, and in whom the maintenance of a desirable depth of anesthesia is difficult, it will be found advantageous to inject morphine sulfate one-sixth to one-fourth grain (0.01-0.016 gm.) intravenously during the course of anesthesia.

For children, especially those under 10 years, only small amounts of pentothal sodium are required for induction. The solution should be injected slowly. We have not yet exceeded the administration of 10 cc. (0.25 gm.) of a 2.5 per cent solution of pentothal sodium to any child under 10 years, the usual dose being 6 cc. (0.150 gm.). The maintenance of anesthesia with nitrous oxide and oxygen is as outlined for adults.

For patients who have a history of cardiac involvement, but in whom the contraindications are not considered absolute, or for those who are elderly or frail, the nasal inhaler is first placed and 100 per cent oxygen is administered for several minutes before injection of the intravenous anesthetic agent. In certain cases, it is possible to increase the amount of oxygen in the arterial blood by approximately 15 per cent by the inhalation of 100 per cent oxygen.[17] Preliminary inhalation of 100 per cent oxygen will decrease the dangers of cardiac anoxia. Premedication should include atropine, but should otherwise be minimal to prevent undue respiratory depression. Surgical procedures for these patients should be limited to short

16. Gordon, R. A.: Bilateral Nasotracheal Intubation for Closed System Anesthesia. Anesthesiology, 5:186, March 1944.

17. Goodman, Louis, and Gilman, Alfred: Pharmacological Basis of Therapeutics. New York: Macmillan Co., 1941, p. 679.

operations. Anesthesia is maintained by the administration of 50 per cent oxygen and 50 per cent nitrous oxide. The percentage of oxygen is increased up to 100 per cent when required to maintain good color. Great care should be exercised to avoid any mechanical obstruction to the respiratory effort.

For persons who have abnormal fear relative to "the use of the needle," the order of procedure may be reversed and enough nitrous oxide-oxygen be first administered to produce analgesia or induction to a stage where the patient is not aware of venipuncture.

It will be found helpful in avoiding psychic trauma in certain apprehensive patients to carry out induction with pentothal sodium in the retiring room, removing the patient to the surgery while he is in a stage of light anesthesia.

UNTOWARD EFFECTS AND EMERGENCIES

The most distressing symptoms that may occur during induction or when anesthesia becomes too light are severe coughing and laryngospasm. When laryngospasm occurs, immediate administration of oxygen is indicated. The anesthetic machine should be set to deliver 100 per cent oxygen under pressure. The operator must make certain that the airway is clear, pull the gauze pack forward and, with the aspirator, remove any mucus or blood that may have accumulated in the pharyngeal area. If the coughing or laryngospasm continues, one one-hundredth grain (0.00065 gm.) of atropine sulfate should be injected intravenously. If the spasms continue, it may be that the plane of anesthesia has become too light. In such cases, injection of additional pentothal sodium is indicated.

If coughing or laryngospasm persists after these measures have been instituted, the administration of pentothal sodium should be discontinued and the use of some other method of anesthesia should be considered.

Sneezing and hiccups usually respond to slow deepening of anesthesia. Tremor rarely occurs and is usually transient. When it is persistent, some other anesthetic agent should be used.

The use of analeptics may be indicated in certain cases when respiratory depression is too profound or the recovery period more prolonged than desired. Picrotoxin, metrazol and nikethamide are analeptics of choice. The dosage of picrotoxin and metrazol is the same; i.e., 1 cc. per minute intravenously. Three cubic centimeters is the usual dose. The analeptic agents are convulsants and their use is not without danger. The administration must cease if retching, vomiting or twitching about the face appears. We have used an analeptic agent only rarely, for the purpose of shortening the recovery time.

A laryngoscope, intratracheal tubes and efficient suction equipment should be available. It is important to remember that the first and most

imperative resuscitative measure, when respiratory embarrassment occurs, is the prompt administration of adequate oxygen under pressure, and artificial respiration when indicated.

IMMEDIATE POSTOPERATIVE CARE

When the operation is completed, the respiratory center is stimulated and the lungs well ventilated for several minutes by the administration of oxygen. In the retiring room, the patient is placed on his side to prevent the tongue from dropping back and to avoid the swallowing of blood. A restraining strap is placed over the patient to prevent rolling onto the floor. He is covered with a blanket and, when deemed desirable, a hot water bottle is placed at the feet. The patient is kept under observation until consciousness has fully returned, at which time a cup of black coffee, with or without sugar, may be given. The result of the coffee administration is often quite striking. Inebriation frequently clears up almost immediately.

The usual length of time that the patient remains in the office after the operation is from one-half to three-quarters of an hour.

When it is decided that he may go home, the patient is released in the custody of some responsible person, who is carefully instructed to keep him under observation during the remainder of the day and evening. This is important, for a patient may have recurring incoordination for some time.

COMMENT

The experience in the use of intravenous anesthetic agents covered in this presentation started in December 1935. Of the 12,528 patients anesthetized, 12,271 received pentothal sodium and 257 received evipal soluble. There were no deaths in this series. Nine hundred and forty-six of these cases had been previously reported.[18]

We prefer pentothal sodium because induction and recovery are quicker and smoother, and annoying side reactions fewer than when evipal soluble is used.

The intermittent injection of small doses of the intravenous anesthetic agent, a method devised by Lundy, is the safest procedure for the administration of pentothal sodium.

It has been interesting to learn that children under 10 years tolerate pentothal sodium very well. The present indications are that the pentothal sodium-nitrous oxide-oxygen combination is not only desirable in oral surgical procedures for children, but also that its use may be very valuable in operative procedures such as cavity preparation for children whose cooperation is otherwise unobtainable.

An increasingly large number of adult patients request the use of intra-

18. Bullard, O. K.: Intravenous Anesthesia in Office Practice for Operations in Exodontia and Oral Surgery: Based on Experience of 946 Cases, Anesth. & Analg., 19:26, January-February 1940.

venous anesthesia for cavity preparation. Such operative procedures can readily be carried out in offices properly equipped and staffed by adequate and well-trained personnel. The administration of intravenous anesthesia should never be attempted by any one not experienced in general anesthetic procedures, nor administered in any office or location where ample measures for resuscitation are not quickly available.

From the standpoint of recovery time, postanesthetic depression and the general comfort and welfare of the patient, it is advantageous, in most instances, to limit surgical procedures to operations that will not require administration of more than 1 gm. of pentothal sodium. It is highly desirable to maintain anesthesia in as light a plane as is compatible with good operative procedures. Occasional slight movement or phonation by the patient does not necessarily call for the injection of additional anesthetic solution. Slight movement sometimes occurs which is not in response to painful stimuli. If the patient receives an additional amount of the anesthetic agent every time he moves, dangerous overdosage may occur.

The oldest patient in this series was 83 years; the youngest, 1 year and 3 days.

The greatest amount of pentothal sodium given during the course of one anesthesia was 4 gm. The postanesthetic recovery period in this case was five hours. In addition to the premedicants, which consisted of pentobarbital sodium $1\frac{1}{2}$ grains (0.1 gm.) and morphine sulfate one-fourth grain (0.016 gm.) with atropine one one-hundredth grain (0.00065 gm.) by mouth, this patient, twice during the course of anesthesia, received one-sixth grain (0.01 gm.) of morphine sulfate intravenously.

The smallest amount of pentothal sodium, 4 cc. of a 1.25 per cent solution (0.05 gm.) was given to the youngest patient, who was 1 year and 3 days old. A light plane of anesthesia was maintained. The patient moved frequently during the short operative procedure and slept one-half hour after the operation.

There must be constant and careful evaluation of the diaphragmatic and intercostal respiratory movements, and vigilant maintenance of the patency of the airway.

CONCLUSION

The use of pentothal sodium with nitrous oxide-oxygen combines the advantages and minimizes the disadvantages of the individual anesthetic agents and provides a method of general anesthesia that is unusually well suited to oral surgical procedures.

2665 Fourth Avenue.

CONTROL OF SUBMANDIBULAR CELLULITIS BY PENICILLIN THERAPY: REPORT OF CASE

LEON J. ALLEN,* D.D.S., Mount Vernon, N. Y.

The following case is submitted as illustrative of the antibacterial properties of penicillin. It also illustrates the failure of sulfatherapy to control and limit the course of infection in this particular situation.

History.—The young woman, aged 20, seen September 28, 1944, complained of general malaise, pain and swelling on the left side of the lower jaw, partial trismus and difficulty in swallowing. On the evening of September 25, under local anesthesia, she had had removed a carious lower left second molar that had been aching intermittently for a week. On the following night, September 26, she began to experience pain and difficulty in opening the mouth and in swallowing. She also noticed that the left side of the lower jaw was beginning to swell.

Clinical Examination.—The swelling was limited to the lower border of the left side of the mandible and the left submaxillary and sublingual areas. The skin was slightly reddish and tender. Intra-orally, there was swelling in the mucobuccal fold in the first and second molar region. The floor of the mouth in the same region was slightly indurated and sore on palpation. The socket and tissue around it were clean. The pterygomandibular area and throat were normal. The floor of the mouth anteriorly and on the right side was normal. The pulse rate was 118; temperature by mouth, 102.8.

Treatment and Course.—Sulfadiazine, 1 gm. every four hours, was prescribed, with hot saline irrigation every hour and general home care. On the following day, September 29, the temperature was 101 and pulse rate 116, but the patient appeared more toxic. External swelling had become diffuse and had spread submandibularly to the midline. The cervical glands on the both sides of the neck were not too tender to touch, although palpation of the right and left supraclavicular areas evoked pain. The skin on the anterior aspect of the neck was also tender. Difficulty in opening the mouth and swallowing were more noticeable. Intra-orally, there was little change on the floor of the mouth. The buccal swelling had progressed forward to the first bicuspid region.

Flaxseed poultices were applied externally. Hot saline irrigation was continued. Sulfamerazine, 1 gm. every eight hours, was prescribed in place of sulfadiazine, of which 7 gm. had been taken by the patient. The following morning, September 30, the temperature was 102.6; pulse rate, 118. The cellulitis had crossed the midline and now involved the whole of the neck. The skin was red and the area of the left submental region extremely sensitive. Induration was most marked in this particular region, giving the impression that localization and pointing might subsequently take place at this point. The anterior aspect of the neck down to the sternum was becoming edema-

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tous, indurated and tender. Swallowing was barely possible. The mouth was almost completely closed.

The patient was placed in the Mt. Vernon Hospital, which fortunately is a distribution center for penicillin for civilian use. Because of the rapid deterioration of the situation, the medical committee in charge of penicillin distribution immediately granted 200,000 units for treatment.

Examination.—On admission to hospital, examination revealed the following conditions: swelling of the neck and lower left part of the face; redness, induration and extreme tenderness in the left submental and sublingual areas; induration extending down alongside the trachea on the left side, and slight edema and tenderness of the skin under the upper part of the chest. The supraclavicular areas were extremely tender. The cervical glands on both sides of the neck were also very sensitive to the touch. The patient could not open the mouth more than 1 cm. and had extreme difficulty in swallowing. The floor of the mouth on the left side was indurated, particularly in the molar region, but anteriorly and on the right side was normal. The patient seemed to be in considerable pain and could not talk or move. The temperature (rectal) was 103.8; pulse rate, 104; respiration, 20.

Blood Examination.—The blood findings were: hemoglobin, 84 per cent; red blood cells, 4,040,000; white blood cells, 21,220; polymorphonuclears, mature, 72 per cent, immature, 20 per cent; lymphocytes, 5 per cent; eosinophils, none; monocytes, 3 per cent; color index, 1.

Diagnosis.—Submandibular cellulitis, possibly developing into a Ludwig's angina, was diagnosed.

Treatment.—On admission at noon September 30, the following instructions were issued: penicillin, 25,000 units in 2 cc. of 5 per cent dextrose parenterally every three hours; forced fluids; codeine sulfate, one-fourth grain parenterally every three or four hours if necessary; flaxseed poultice every hour; hot saline irrigation every two hours; sulfamerazine, 1 gm. at 3 p.m., then discontinuance of all sulfa treatment; urinalysis and blood culture.

Observations.—At 8 p.m. the same day, there was no change in the clinical picture. Orders were left to apply flaxseed one hour out of every two hours. The temperature had declined from 103.8 to 102.8. The pulse rate was 100. The following morning, October 1, at 8 a.m., the temperature had dropped sharply to 100.8 and the pulse rate was 80.

Clinical observation at 10 a.m., October 1, twenty-two hours after admission, revealed that the progress of the cellulitis was definitely arrested. There was a slight diminution of the cellulitis on the left side. The glands were not so tender. There was no tendency to point or localize. The patient appeared more cheerful and could swallow, but still with great difficulty. Greenish pus was exuding from the molar socket.

At this point, a change was made in administration of the penicillin. Owing to the fact that additional quantities of the drug were unavailable until the following morning, the last dose of 25,000 units was broken up into two doses of 10,000 units and one of 5,000 units, to be administered at three-hour intervals respectively.

At 7:30 p.m. the same day, the temperature was 102; pulse rate, 100. Clini-

cally, there was a marked change for the better. There was a decrease in the extent of the swelling. The tenderness of the glands of the neck was markedly reduced, although still present on the right side. The skin on the chest was only slightly sore on pressure. Pus was still exuding from the socket. The swallowing, although still painful, was not so difficult. The flaxseed poultice application was reduced to one hour out of every three hours. The hot saline irrigation continued as previously prescribed.

October 2, at 8 a.m., the temperature was 100; pulse rate, 80. There was continued improvement in the appearance of the patient and the cellulitis was notably decreasing. Trismus was still present, and the difficulty in swallowing was about the same. The glands were less tender on palpation.

Treatment and Course.—The flaxseed poultice was discontinued. Penicillin was again administered, this time in doses of 20,000 units in 2 cc. of 5 per cent dextrose every four hours for a total of 100,000 units. At 5 p.m. the same day, the temperature was still 100; pulse rate, 100. There was continued improvement clinically. The glands were no longer tender on the right side. The patient could swallow easily on the right side and open the mouth freely. The induration and cellulitis on the left side were subsiding without any tendency to point or fluctuate. Pus exuded freely from the socket. A culture was ordered.

October 3, at 9:30 a.m., there was continued resolution. A blood count and urinalysis were ordered. Saline irrigation was given every three hours. At 7:30 p.m., swallowing was normal. The patient could open the mouth 3 or 4 cm. There was continued reduction in the swelling. Very little tenderness was evident.

The patient was discharged from hospital October 4 at noon, exactly four days after admission. The subsequent course was uncomplicated and resolution was complete.

Progress continued uneventfully. The patient was seen at the office October 5 and 7. The socket was irrigated with zephiran chloride 1:4,000 dilution. The diet was supplemented with multiple vitamins. October 9, the patient went back to work. October 10, roentgenographic examination disclosed no pathologic process of the bone. The patient was last seen October 14, at which time there was no clinical evidence of swelling except for a small hard area, which had been resolving gradually, along the buccal aspect of the socket.

Laboratory Findings.—The blood count is shown in the accompanying tabulation.

BLOOD COUNT

	Hemoglobin Per Cent	Red Cells	White Cells	Polymorphonuclears Mature	Polymorphonuclears Immature	Lymphocytes	Eosinophils	Monocytes
9/30/44	84	4,040,000	21,220	70	20	5	0	3
10/ 3/44	79	4,050,000	6,000*	53	16	18	5	8
10/ 5/44		4,690,000	12,550	25	45	24	5	1

*Sharp decline attributed to an idiosyncrasy to sulfatherapy.

The blood culture was sterile after seventy-two hours of incubation. The pus culture showed the fusiform organisms of Vincent's angina and nonhemolytic *Staphylococcus aureus.*

COMMENT

The interesting fact observed is not only the rapidity with which a very stormy situation was brought under control, but also the speed with which resolution and convalescence occurred.

The value of penicillin as a militant aid in the control of facial and cervical cellulitis is becoming more evident as reports come in. The dosage of penicillin on an hourly basis was approximately 8,300 Oxford units for the first 200,000 units and 5,000 Oxford units for the second 100,000 units.

117 South Second Avenue.

Accidental Discovery of Penicillin.—In an address at the King's Chapel of the Savoy on Hospital Sunday (when donations for the hospitals are collected) Alexander Fleming, the discoverer of penicillin, delivered an address. The discovery, he said, illustrated the great value of the freedom to pursue research which was so prominent in the voluntary hospital and might be restricted under a more bureaucratic system. Like many bacteriologists, Professor Fleming related, he had many culture plates contaminated with mold spores which drop from the air, and, like every other bacteriologist, he had cast them out with suitable expressions of annoyance. But on this one occasion he did not, and penicillin was the result. He noticed that the molds prevented growth of the culture for a small area. It seemed providential that the most powerful agent against septic infection was discovered at this time, when we were plunged into a bloody war. Penicillin has already done much to alleviate the sufferings of the wounded, Fleming stated, and will do more as the supply increases. In the last war, the infected wounds of many soldiers remained open for six months or more, with frequent painful dressings. Now it is hoped that, by the aid of penicillin, they will not become infected at all or that, if they do, many will heal in a month or less.—London Letter, *J.A.M.A.*, September 9, 1944.

UMI

NEW TECHNIC FOR CORRECTION OF MACROSTOMIA

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It is generally agreed that we learn by our mistakes and benefit by our observations, and that we are stimulated to better work by our shortcomings. It is not until we have erred or tried current procedures with fair or unsatisfactory results that we begin to take inventory of ourselves or of the technic that we are using, in order to determine the cause of poor results.

I have had the occasion, in several instances, to correct the congenital condition of macrostomia; and although I had had the privilege of assist-

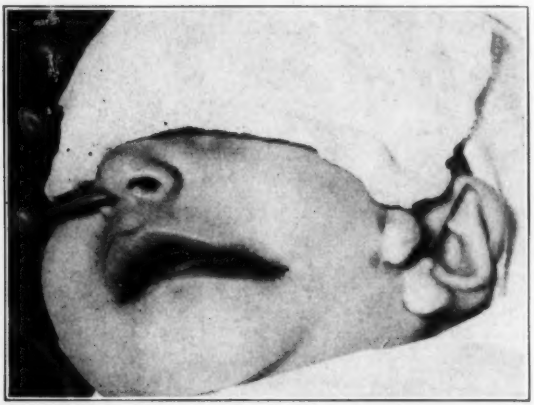

Fig. 1 (Case 1).—Child with unilateral macrostomia, also supernumerary ear buds.

ing one of our capable surgeons in performing this operation, several times, some time ago, I felt the need of refreshing my memory as to technic. Texts were therefore reviewed and the usual technic described was carried out. In the operation usually described, a triangle is removed from the commissure on each side of the mouth and then mucous membrane approximated with mucous membrane, muscle with muscle, skin with skin.

This technic was tried in two cases. The size of the mouth was decreased, but the secondary effects were, in my opinion, not satisfactory. The scar in each commissure was thick. This area on occasions became fissured and healing difficult because of the constant pull of the muscles at the angles.

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Fig. 2 (Case 1).—Incision of affected side at mucocutaneous border and formation of triangular flap in mucous membrane of upper lip, with base equal to width of vermilion border of upper lip and located at external end of orbicularis oris muscle.

Fig. 3 (Case 1).—Triangular flap dissected above and below and mucous membrane of inside of cheek dissected and undermined below. This is done in order to have the suture line of the mucous membrane at a different level from that of the muscle layer.

Foman[1] writes: "Plastic operations designed for the correction of this deformity usually fall short of satisfaction, as the residual scars are likely

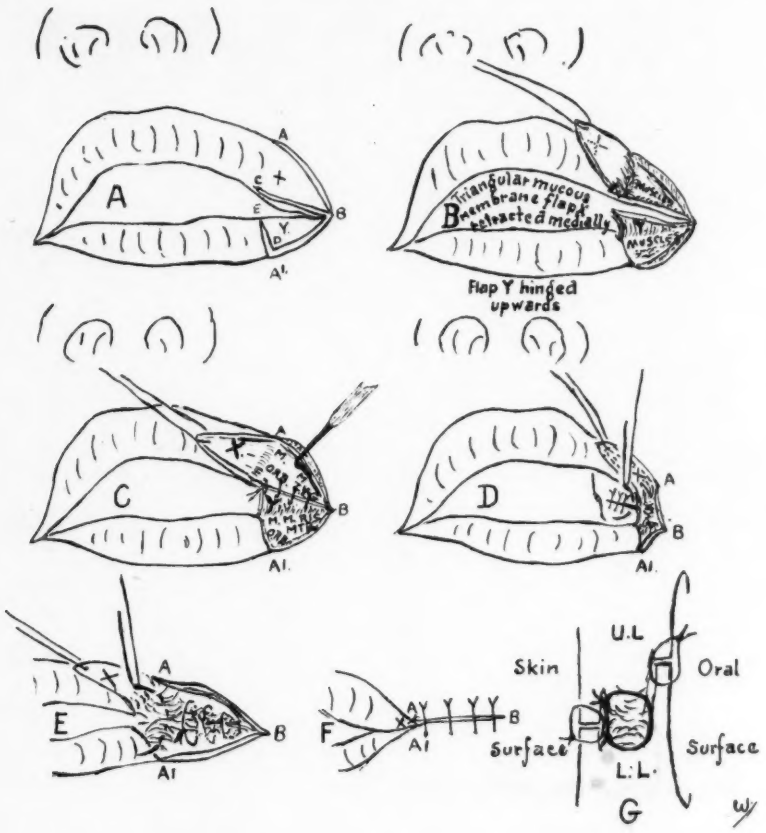

Fig. 4.—*A*, incisions outlining mucous membrane flaps. *B*, flap *X* undermined and retracted medially; flap *Y* undermined and hinged upward. *C* and *D*, flap *Y* sutured to oral margin *B-C* with triple O chromic catgut tied on oral surface. *E*, suturing of musculature and connective tissue (orbicularis, zygomaticus, risorius, triangularis) with triple O chromic catgut. *F*, skin suture; mucous membrane flap *X* trimmed and sutured into angle of mouth. *G*, cross-section; suturing of layers on different horizontal levels.

to be as disfiguring as the original condition." This is true with the methods of correction mentioned to date.

Foman continues: ". . . shortening may be accomplished by the removal from either lip, just medial to the commissure of two quadrilateral sections of full thickness tissue of such a size that when the wound margins are united, the mouth will be of proper dimensions. The mucosa was approxi-

mated with catgut, as one layer, and skin is carefully sutured with horse hair."

Joseph, in an effort to eliminate scarring in the vicinity of the commissure, advocated the excision of two vertical strips of tissue from the upper lip on each side of the philtrum and the removal of a section of tissue from the central part of the lower lip.

In the less severe cases, where the V-Y operation can be done, this complication does not occur so readily. We are now concerned with extreme macrostomia and, as Davis describes it, the only procedure used at this time that has been reported is complete division of the tissues and the resuturing of them in layers. It is this technic which prompted me to seek some method that would eliminate the untoward results of its use.

Fig. 5 (Case 1).—Triangular flap dissected to upper orbicularis oris muscle and approximation of mucous membrane of cheek by first suture.

Diagnosis of the condition is simple, the amount of involvement being the only point in consideration. Embryologically, we know that there is a defective union of the mandibular and maxillary processes. The condition may be unilateral or bilateral. The condition may vary from a simple submucous separation of the muscle fibers of the orbicularis oris muscle to complete separation of the tissues to the margins of the masseter muscle.

Vaughn[2] describes macrostomia as an oblique facial cleft extending through the angle of the mouth to the eye or beyond. The cleft may be through the soft tissues or it may pass through the alveolar ridge as a

small fissure, extending through the hard and soft palates. Invariably, there are other associated congenital defects. In one of my cases, there were supernumerary remnants of ears. (Fig. 1.)

The technic that I have adopted is as follows: An incision is made at the mucocutaneous junction, beginning at the angle and carried to the region at the external end of the orbicularis muscle above and below. The mucous membrane is then undermined above and below, from the angle and for a distance from 0 at the angle to about 0.50 to 0.75 cm. at the termination of the incision above. (Fig. 2.)

A triangular flap is then made in the mucous membrane only, either above or below. (Fig. 3.) In bilateral clefts, I reverse the location of the

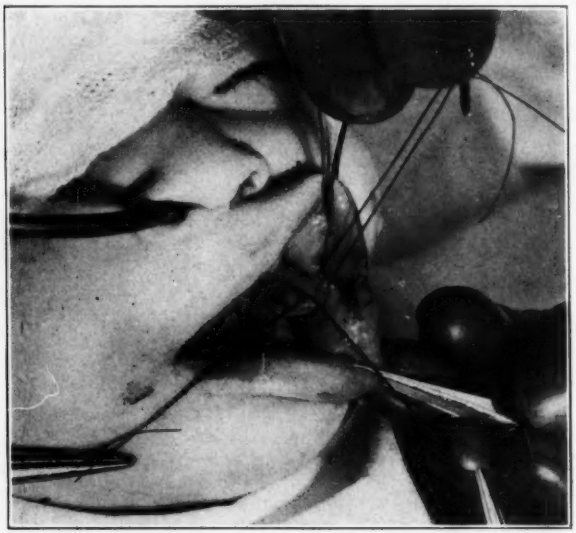

Fig. 6 (Case 1).—Approximation of mucous membrane and first suture in muscle.

triangles, making one on the upper lip on one side and one on the lower lip on the other side. The apex of the triangle is made at the angle of the mouth. The base of the triangle is made just beyond the termination of the original incision or corresponding to the external end or beginning of the orbicularis muscle, whichever it may be. This triangle is then dissected away from the submucous tissue. (Fig. 4 *B*.) The incision is then continued along the mucocutaneous junction of the lower lip for a distance equal to about one third the length of the triangular flap previously dissected from the upper lip. This incision is then continued across the vermilion border over the rounded area produced by the prominence made by the end of the orbicularis on the lower lip; thus exposing the end of

the orbicularis muscle. The mucous membrane flap thus outlined is then undermined for a distance equal to the width of the base of the upper flap.

The first triangle of mucous membrane from the upper lip gives a mucous membrane flap and leaves a raw surface on the inner surface of the cheek. It also exposes the raw external end of the orbicularis muscle.

By undermining the mucous membrane of the lower leaf of the cheek and reflecting a mucous membrane flap, the lower end of the orbicularis oris is exposed, and there is produced a triangular defect between the skin and the mucous membrane over the lower orbicularis muscle. (Fig. 4 *B.*)

This mucous membrane flap is then sutured to the mucous membrane

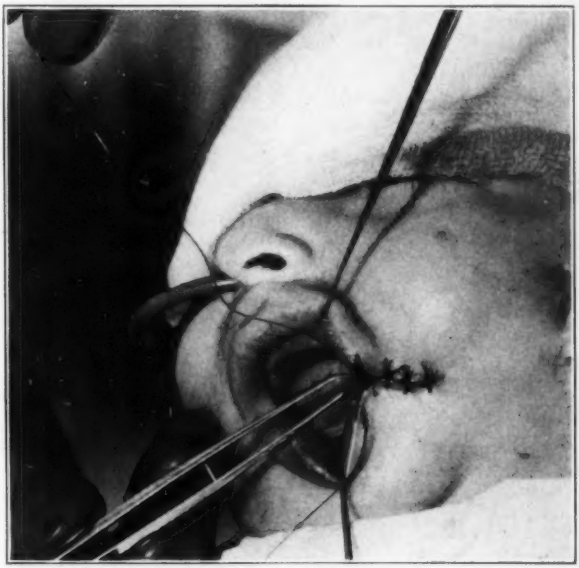

Fig. 7 (Case 1).—Approximation of skin after closure of mucous membrane; approximation of muscle tissue at different level and suture through triangular flap of mucous membrane, which will be pulled across suture line and fitted into space provided for it between flap of mucous membrane of lower lip and skin of lower part of cheek after flap has been trimmed to fit.

of the upper side with triple chromic interrupted catgut suture, the knots being tied inside the mouth. This suture line then covers the previously produced raw area where the triangular flap was made and at a line above the subsequent suturing of the muscles. This suturing of the mucous lining is continued medially up to the base of the triangular flap of mucous membrane. (Fig. 4 *C, D.*)

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Fig. 8 (Case 1).—Condition fourteen days after operation.

Fig. 9 (Case 2).—Child with bilateral macrostomia; after operation (right).

The soft tissues of the cheek lining are then approximated; or, if the division extends laterally as far as the insertion of the zygomaticus major above and the risorius and triangularis below, the fascia of these muscles are sutured to each other. Two or three interrupted triple o chromic catgut sutures may be used. (Fig. 4 *E*.)

Next, the skin is closed with interrupted plastic sutures until the new skin margin of the future lip is reached. (Fig. 4 *F*; Fig. 7.) The triangular flap of mucous membrane from the upper lip is now inserted and fitted

between the skin laterally and the mucous membrane of the lower lip medially. The excess at the apex of the flap is amputated. Now the ends of the orbicularis oris muscle above and below are united. The mucous membrane flap is then sutured to place. (Fig. 4 *F*.)

Tincture of benzoin is applied to the suture line. No other dressing is necessary.

It can be seen that the lines of suture are placed at different levels. (Fig. 4 *G*.) The critical angle is covered by a mucous membrane flap. It is the difference in the approximation of the tissues at different levels that prevents the straight lateral pull and rigidity which usually follow the common type of layer closure, and it is the overlapping of the angle by the mucous membrane flap that gives a round sulcus in place of a scarred fissure and prevents fissuring of the angle and the rigidity produced by the chronic irritation at that point.

Fig. 10 (Case 2).—Condition fourteen days after operation. It is evident that the flap produces a round covering of mucous membrane for the commissure.

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UMI

STENOSIS OF THE OROPHARYNX

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Stenosis of the oropharynx, a rare condition, is characterized by the presence of scar tissue causing constriction involving the soft palate, tonsil region and base of the tongue. These scar bands may be caused by an ulcerative lesion, which can destroy the normal mucous membrane. Destruction of the mucous membrane may be due to syphilis, diphtheria,

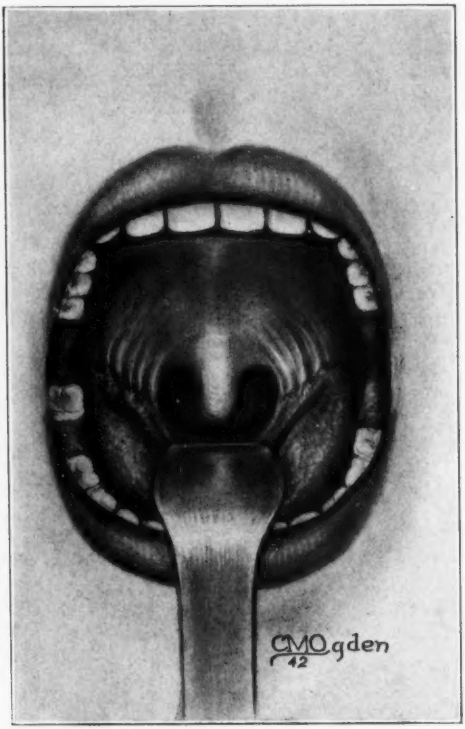

Fig. 1.—Marked constriction of oropharynx due to scar tissue adhesions of tongue and tonsillar fossae and pillars.

Vincent's infection, tuberculosis, trauma or contact with caustics. The most common cause seems to be tonsillectomy, and it is more likely to occur when the lingual tonsils are removed at the same time that the tonsils are enucleated. In these cases, there is likely to be a continuous raw area extending

from the tonsillar fossa to the side of the tongue, and, when healing takes place, each side of the tongue is gradually drawn into its tonsillar fossa. Usually, there is no difficulty in talking and swallowing, and the stenosis remains unnoticed. Occasionally, there is an impediment of speech as well as difficulty in swallowing food. Such a case will be described.

The severity of these cases depends on the loss of normal mucous membrane lining the pharynx. Syphilitic ulcerative lesions are responsible for the most serious functional handicaps. It is not uncommon to see cases wherein the pharyngeal walls are covered with a mass of scar tissue, with troublesome nasopharyngeal stenosis, as well as narrowing of the hypopharynx.

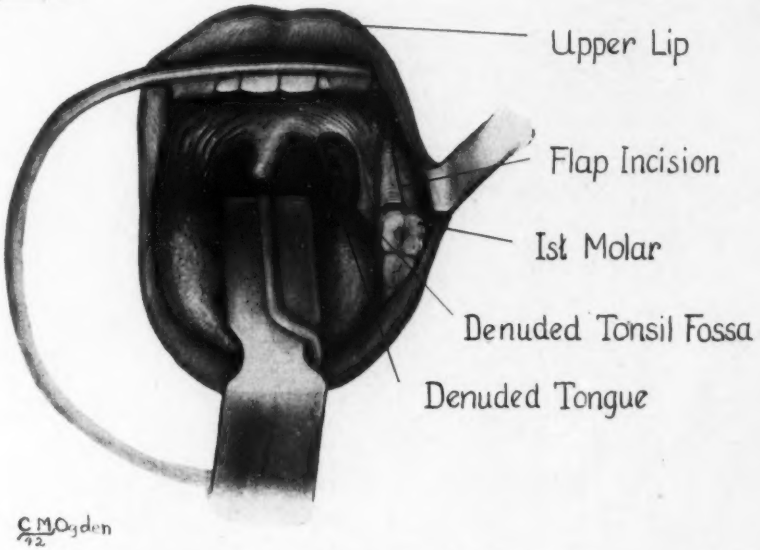

Fig. 2.—Tongue completely freed from pharyngeal wall on left side; outline of mucous membrane flap to cover denuded area.

TREATMENT

It is suggested that during tonsillectomy, when the lingual tonsils are removed, the operator, as a preventive measure, take care to maintain a normal mucous membrane between the raw area of the tonsillar fossa and the base of the tongue, to prevent adhesion of the two raw areas.

In 1901, Curtis[1] reported the case of a young woman, the victim of congenital syphilis, who had such an extensive constriction of the

1. Curtis, B. F.: Cicatricial Stricture of Pharynx Cured by Plastic Operation. Ann. Surg., 33:153-156, 1901.

oropharynx that it was difficult for her to take nourishment. The opening through which she was obliged to breathe and to swallow her food was only one quarter inch in diameter. Curtis describes an ingenious operation that exposed the stenosed pharynx by a transverse incision of the neck. After the cicatricial bands were stretched, a pedicled flap was shifted from the side of the neck to cover the raw area of the pharynx. Later on, another operation closed the opening in the neck.

Dorrance[2] reported a case in which the sides of the tongue were drawn up into the tonsillar fossa by scar tissue following tonsillectomy. He lined an artificial cavity on each side of the stricture with a skin graft, and later connected these cavities with the opening that remained in the pharynx

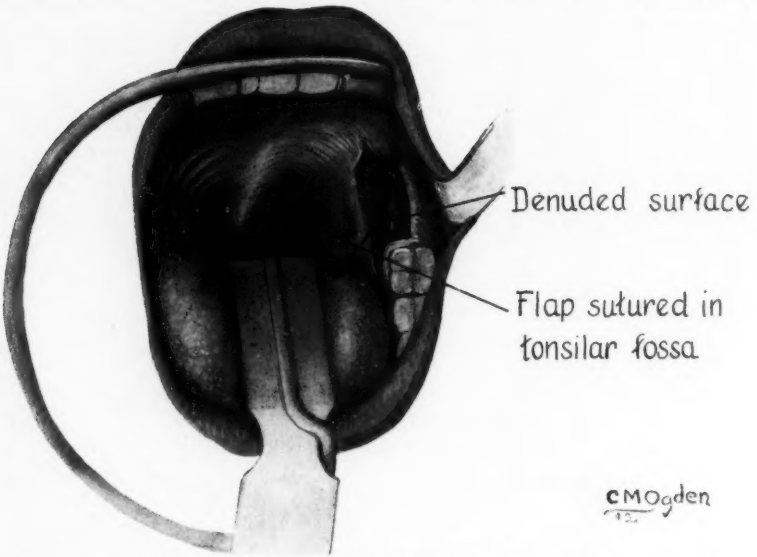

Fig. 3.—Flap shifted and sutured to restore height of pillar and pharyngeal wall.

at the site of the stricture. This was followed by continuous pressure, until the three cavities became one for all practical purposes. Through incisions adjacent to the tongue on both sides of the stricture, dissection was carried upward and sideways toward the pharyngeal wall, and olive-shaped vulcanite forms were coated with Thiersch grafts and held in place in these cavities by suturing the incisions. When the grafts had "taken," secondary incisions were made from the opening into the pharynx laterally through each of these lined cavities, and then a rubber ringed pessary was inserted,

2. Dorrance, G. M.: Treatment of Strictures of the Oropharynx. Arch. Otolaryng., 15:731-736, February 1931.

so that these newly formed cavities might communicate with each other and the oropharynx.

I have attempted skin grafting in one case with a technic similar to that described by Dorrance, but with mediocre success. The constant mobility of the pharynx in talking or swallowing creates difficulty in skin grafting in this area.

REPORT OF CASE

History.—A young woman, aged 21, had had an operation for the removal of tonsillar remnants and hypertrophied lingual tonsils and, as a result, the raw area on the tongue contracted to the tonsillar fossa to such an extent that

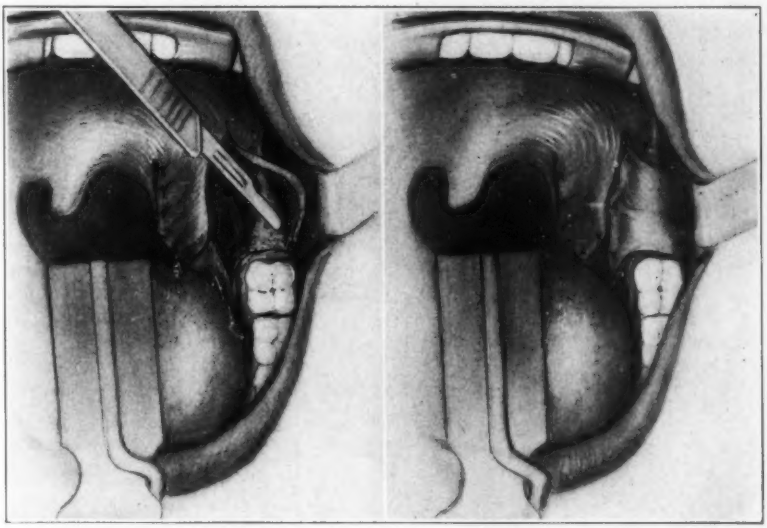

Fig. 4.—Left: Buccal mucosa freely undermined to permit its sliding medially to cover defect produced by shifting flap to restore pharynx. Right: Buccal mucosa sutured over defect.

great difficulty was experienced in eating and there was an impediment in speech.

Examination.—Both sides of the tongue were adherent to the tonsillar fossae (Fig. 1), formation of a tubular space resulting between the soft palate and the base of the tongue.

Operation.—Under general anesthesia, the head was put in the Rose position and, with a Brown-Davis gag, a good view of the operative field was obtained. With a sharp scalpel, an incision was made through the scar and the tongue was completely freed from the pharyngeal wall.

In order to cover the raw area resulting (Fig. 2) with epithelial tissue, a rectangular flap was made from the anterior pillar, extending over the alveolar

ridge back of the molar tooth. This flap was shifted over the raw area on the tonsillar fossa and part of the raw area on the tongue. (Fig. 3.)

This left another raw area, which might have healed of itself, but, to eliminate the possibility of further contraction, a second flap was taken from the buccal mucosa. To create this flap, the incision on the alveolar ridge was extended laterally into the cheek. By undermining, this flap was readily drawn and sutured into the defect. (Fig. 4.)

After this operation, it was unnecessary to use modeling composition or protective dressings, as the essential denuded areas were covered with epithelium, the only precaution required being general oral hygiene. A similar operation was then carried out on the other side.

Outcome.—Speech and swallowing improved immediately. After the area had healed, improvement continued, and an examination of the throat nine months after the operation revealed a normal condition. (Fig. 5.)

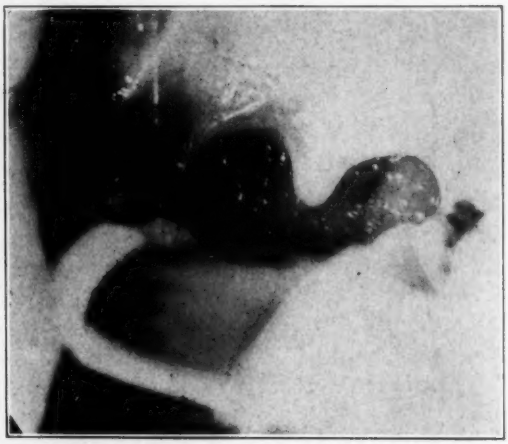

Fig. 5.—End-result; normal space between uvula and base of tonsillar fossa. (Compare Fig. 1.)

Why might not this deformity be corrected by merely freeing the tongue from the tonsillar fossa, and then joining the anterior and posterior pillars, thus avoiding flaps? This simpler method has been tried in other cases, but the results were discouraging. The sutures invariably gave way, and the raw surfaces and subsequent scars again drew the tongue into the tonsillar fossae.

SUMMARY

Stenosis of the oropharynx, a rare condition, may follow ulcerative or operative destruction of the mucous membrane. The cases most frequently seen are due to tonsillectomy that includes removal of the lingual tonsils.

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In the case of stenosis of the oropharynx presented, treatment consisted of freeing the scar bands and covering the resulting raw area with rectangular pedicled flaps from the anterior pillar, postmolar region and cheek.

Progress in Oral Surgery, Anesthesia and Radiology.—In these later years, the development of local anesthesia has been a great factor in the development of oral surgery. As we have seen earlier in this discussion, local anesthesia was being sought for soon after the Civil War, but little progress was made until the later eighteen hundred seventies. "It was awakened into new life by the efforts of Koller, Schleigh, Robson and others. At the Congress of Ophthalmology held in Heidelberg in 1884, Koller demonstrated the remarkable anesthetizing power of cocaine." It quickly sprang into general popularity. The methods of its application then were crude and, in anesthetizing the mucous membrane, many fatalities occurred on account of the toxicity of the cocaine. As yet no means had been discovered for controlling the anesthetic agent in the tissues and, when once injected, it spread throughout the blood streams, with a general toxic effect. They experimented with comparatively small doses, but found certain persons whose reactions were unfavorable even to slight amounts. While many investigators were experimenting on the dosage of cocaine, Braun was working on a different principle. He thought that if something could be found which would combine with the anesthetic agent, but would not detract from its anesthetizing power, and which would contract the blood vessels and prevent spreading of the agent through the blood stream, not only would the anesthetic agent be safer, but also its value would be enhanced. It was he who first suggested the admixture of extract of the suprarenal capsule with the anesthetic solution. All of the early investigators recognized the toxic effects of cocaine on the heart and central nervous system, and substitutes were offered from time to time such as eucaine, holocaine, tropacocaine and stovaine, but all were found to possess less anesthetizing power than cocaine. In the investigation for a substitute for cocaine, Braun laid down the following requirements for a local anesthetic: 1. The substance must be the equal of cocaine in its anesthetizing power. 2. The substance must be less toxic than cocaine. 3. The agent must cause the slightest irritation to the tissues. 4. The solution must be soluble in water, reasonably stable and sterilizable by simple means. 5. It must combine readily with some hemostatic agent, such as epinephrine. Procaine hydrochloride seems to have fulfilled these requirements. . . . Conduction anesthesia has made possible many operations about the mouth and jaws that otherwise would have been performed under a general anesthetic. The very fact that many of these operations could be performed under a local anesthetic was a stimulus for many men to take up oral surgery as a specialty.—Chalmers J. Lyons, in *J.A.D.A.*, 1935.

UMI

MYOSITIS OSSIFICANS OF RIGHT MASSETER MUSCLE: REPORT OF A CASE

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History.—A laborer, colored, aged 28, two months earlier, while pushing a cart at work, fell, and the handle of the cart struck the right side of the face. At that time, there was no particular discomfort. During the ensuing two months, the right side of the face gradually increased in size and it became increasingly difficult to open the jaws.

Fig. 1.—Complete calcification of right masseter muscle from body of mandible to zygoma.

Examination.—Temperature, pulse and respiration were normal. The blood pressure was 110/70. Physical findings were within normal limits.

X-Ray Examination.—There was considerable calcification in the masseter muscle on the right side.

Operation.—The patient was admitted to the oral surgery service of the Pennsylvania Hospital and, July 28, 1941, was operated on for removal of

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calcified tissue. Under avertin (tribromethanol)-ether anesthesia, an incision was made beginning just above the angle of the right side of the mandible and conforming to the lower border, extending forward about 2½ inches. No abnormal tissues were seen until the masseter muscle was exposed. In separating the fibers of the muscle sheath, a bony mass, 2.5 cm. in size, was encountered. This was removed. There was no further evidence of calcification. The fascia was sutured with No. 000 chromic gut and the skin closed with interrupted black silk sutures.

Progress.—The recovery period was uneventful, but the patient was uncom-

Fig. 2.—Lateral surface of ossified masseter muscle.

fortable for a week. Edema persisted over the right side of the face during this time. As the edema subsided, it became possible to open the jaws without difficulty.

One month after the operation, the jaws began to stiffen again and the cheek was hard to palpation. The trismus and induration increased. It was believed that surgical intervention should not be again attempted until calcification of the muscle was complete. In the interim, the patient was given

an x-ray examination once a month. Six months later, as the x-ray film showed no further increase in density, it was believed that calcification was complete.

Examination on readmission revealed no general physical changes. The orofacial examination disclosed complete trismus with definite enlargement of the right cheek which, on palpation, had bony characteristics.

Second Operation.—The surgical technic was similar to that of the first procedure. The muscle was completely calcified from its origin on the zygoma

Fig. 3.—Medial surface of ossified masseter muscle.

to its insertion on the mandible. The mandibular and zygomatic attachments were severed by means of mallet and chisel. The entire muscle was removed *en masse*. Its measurements were approximately 8 by 4 by 2 cm. The wound was closed in the usual manner. A small Penrose drain was inserted. The gross specimen appeared in every way to be muscle tissue in a "petrified" state.

Progress.—Convalescence was uneventful. On the second day after operation, the jaws could be opened one-half inch and the patient was able to take

a soft diet. He was discharged from the hospital on the sixth day, well satisfied with his ability to eat and talk normally again.

Pathologic Diagnosis.—Myositis ossificans of the masseter muscle was diagnosed.

Outcome.—Six months later, the patient began to show symptoms of further calcification. Nine months after his second operation, the x-rays disclosed further calcification in the same area. On readmission, a small amount of calcified muscle was removed from the masseter attachments. Recovery was uneventful and, in a few days, the patient was discharged. He has not returned for follow-up study.

In my review of the literature, I have been unable to find any report of myositis ossificans of the masseter muscle.

Nineteenth and Spruce Streets.

Sulfonamides in Compound Fractures.—The factors involved in the correct plan of treatment of such injuries are as follows: 1. Early and thorough débridement by a competent, conscientious and painstaking surgeon. 2. Reduction of the fracture with fixation of the fragments by means of internal splints if necessary. 3. The use of the sulfonamides as an adjunct in the treatment of these compound wounds. . . . The benefits of this method of treatment were real and satisfactory. 1. It was possible to close every wound without drainage. 2. Osteitis or osteomyelitis did not develop in any case. 3. Owing to the primary closure of the wound, skin grafting was unnecessary in any case. 4. In fractures near the joints with the wound closed, much earlier and fuller motion could be obtained than in those with the wound open. 5. Dressings of the wound with the consequent contamination which sometimes occurs in open wounds and the loss of valuable time of trained workers was cut to a minimum by the elimination of the open wound. 6. In only one case was a second operation necessary to remove the steel plate. In a previous series by the Carrel-Dakin method, the plate was removed in 68 per cent of the cases.—Foster, in *Surg., Gynec. & Obst.*, September 1944.

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TEMPORARY EXTERNAL SALIVARY DRAINAGE (FROM STENSON'S DUCT) FOLLOWING ARTHROPLASTY

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Externally draining salivary fistulae can be very annoying to the surgeon as well as the patient. When one occurs as a result of a surgical operation, the situation may be very disconcerting. The operator wonders whether the malady that called for surgical interference might not have been less deleterious than the complication. The case here reported had a satisfactory outcome, but was the cause of some concern. The rather unusual reason for the temporary external drainage from the parotid duct justifies its recording.

REPORT OF CASE

History.—A girl, aged 13, presented an osseous ankylosis of the left temporomandibular joint. She had fallen to the floor when a few months of age and struck the symphysis of the mandible. Shortly thereafter, the mother noticed limitation of motion, which developed into complete fixation at 2 years of age. At that time, an unsuccessful attempt at condylar resection was made. There was a linear scar in front of the left ear as evidence of the procedure. At the time for our first observation, there was possible a vertical opening in the incisor area of about 2 mm.

Operation.—The patient was hospitalized and, under general anesthesia, a Risdon type of arthroplasty—resection of the ramus[1]—was performed. An incision 1½ inches in length was made through the skin, fascia and masseter muscle down to the bone at the left angle of the mandible. The masseter was elevated from the ascending ramus, the lower two-thirds being exposed. A full curved Gigli saw leader needle was then inserted around the medial side of the ramus postero-anteriorly, above the mandibular foramen. A small incision was made through the skin at the anterior border of the ramus where the needle end could be palpated and the needle was forced through the cheek at this point. As the needle tip protruded, it was noticed that some strands of tissue were engaged in the opening on the end of the instrument. These were dislodged and the Gigli saw was placed on the needle, which was withdrawn, leaving the saw in place.

The ramus was then resected horizontally. About one-fourth to one-half inch of bone was removed from the upper fragment and some from the lower across their whole width. The medial side of the masseter was split so as to raise a flap, which was moved into the space between the fragments and sutured to the internal pterygoid fascia with 000 chromic sutures. Sulfathiazole was

1. Risdon, Fulton: Ankylosis of Temporomaxillary Joint. *J.A.D.A.*, 21:1933, November 1934.

inserted in the wound and the masseter approximated with buried ooo chromic sutures. The skin was approximated with subcuticular silk and caldermic interrupted surface sutures. There was free movement of the mandible postoperatively.

Course.—The postoperative course was uneventful and the patient was discharged on the sixth postoperative day.

Nineteen days after operation, the patient reported at the office with localized swelling and fluctuation at the site of the anterior incision. Clear saliva was expressed. For two weeks, there was salivary drainage from the opening, with increased flow at each meal. A tight adhesive tape cover was placed directly over the opening. For a few days, the saliva occasionally forced its way out

Fig. 1.—Adhesive tape in place, acting as external dam for saliva

under the tape, but the external drainage soon ceased and the saliva continued on its normal course through the terminal portion of the duct. One month later, the facial discharge had not reappeared and the wound was in satisfactory condition in all respects.

COMMENTS

As no parotid substance is normally found at the site of the anterior incision, the saliva must have escaped through a lacerated duct or from an accessory and separate parotid lobe, *socia parotidis.* Two possibilities of damage to Stenson's duct exist: from engagement of the duct by the needle

during its course to the surface and from division of the canal by the Gigli saw. The former, in the light of the operative history, seems to me to be the more likely to occur. If this is true, it is apparent that this possible complication should be kept in mind and the needle carefully watched as it makes its exit. The engaged tissue, if any, should be gently removed. However,

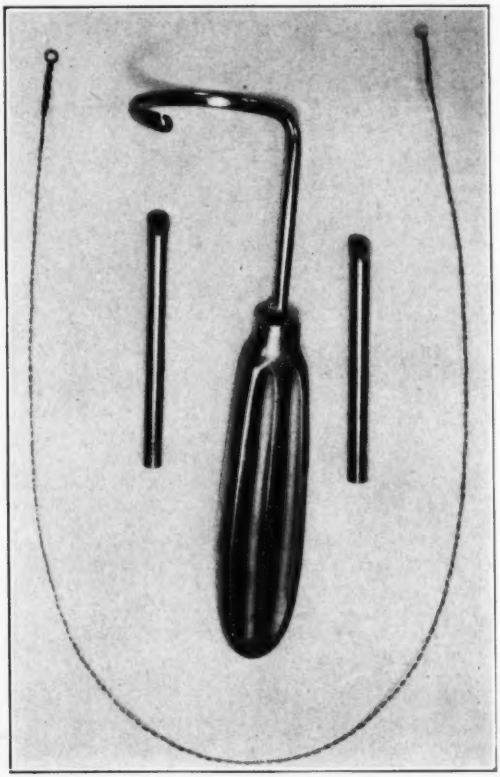

Fig. 2.—Instruments used in osteotomy: pathfinder, Gigli saw and saw guides to protect soft tissues.

the mathematical chance of a repetition of this incident seems rather remote. The needle, a very useful instrument, designed by Reed O. Dingman, of the University Hospital, Ann Arbor, Mich., has been employed many other times without a similar experience.

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